IEEE P802.11
Wireless LANs

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| --- |
| Frame Anonymization  |
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Abstract

This submission is normative text for the individual and group EDP epochs.

The automatic EDP epochs is presented in submission 11-24-579r0.

The group EDP epochs is presented in submission 11-23-1984r3.

Version history:

V0 was presented and discussed on 802.11bi meeting sloton Wed 3/13 PM2.

V1 incorporates the feedback from the 802.11bi. The submission follows more closely 802.11bi D0.2 structure.

V2 incorporates the feedback from the TG after presentation.

V3 integrates more feedback.

V4 integrates 11-24-0645 and comments from 11-24-731.

V5: Changes in this version:

* This doc only captures the epoch framework. The actual anonymization of fields such as STA MAC address, AID, PN, SN, subset of MAC header frames, etc. will be discussed separately in another document.
* Left the minimum EPOCH duration TBD but no shorter than 1s.
* Removed AID obfuscation.
* Replaced the Individual epoch by EDP epoch request.
* A CPE STA can request starting a group EDP epoch (with preferred epoch parameters specified) or request to join a specify Group epoch (with Group ID specified).
* CPE AP accepts or rejects the request. The CPE AP can create a new group EDP epoch to match the requested parameters or ask the STA to join an existing group EDP epoch with same parameters.
* Group EDP epoch can have one or more CPE STAs as members.

## 10.71.2.1 Introduction

*Instructions to the 802.11bi Editor: Please add the following changes as shown with track changes.*

## A CPE AP provides anonymization of selected OTA fields of individually addressed frames of associated CPE STAs by means of EDP epoch.

## An EDP epoch(#Ed) is a time window in which a set of EDP parameters remain constant. EDP epoch(#Ed) operation is an EDP feature that is valid when MLO is supported.

## A group(#Ed) EDP epoch(#Ed) sequence is created by an AP MLD advertising the EDP epoch(#Ed) support in beacons and probe responses. A group EDP epoch has zero or more STAs as its members. A CPE AP advertises at least a default group EDP epoch, and possibly other group epochs. All CPE STAs joining the BSS are placed in the default group EDP epoch by default upon association. If a CPE STA does not prefer to join any of the existing group EDP epochs, it sends an EDP epoch sequence request to the CPE AP to create a new group EDP epoch. A CPE STA can request to leave any group and/or join a different group at any time.

## The AP MLD advertises the EDP epoch (#Ed) parameters as defined in 10.71.2.3 (EDP Epoch Settings (#Ed))(#Ed). Each non-AP MLD of the set of non-AP MLDs member of the group applies the advertised EDP epoch(#Ed) parameters of the group(#Ed) EDP epoch(#Ed) to determine the same EDP epoch(#Ed) sequence of one or more EDP epoch(#Ed) start times.

EDP epoch allows the AP to define a BSS-specific schedule of anonymization events to anonymize the selected OTA fields (e.g., STA MAC address, AID, PN, SN, etc.) of individually addressed frames.

All EDP epochs have a similar anonymization mechanism for the MAC Header fields of the individually addressed frames as defined in 10.71.3 (Establishing frame anonymization parameter sets), 10.71.4 (Frame anonymization and transmitting functions) and 10.71.5 (Frame anonymization receiving functions).

**10.71.2.2 EDP epoch(#Ed) setup**

*Instructions to the 802.11bi Editor: Please delete this clause and its subclauses.*

**10.71.2.2 EDP epoch request**

*Instructions to the 802.11bi Editor: Please add this clause and renumber the following clauses.*

A CPE STA shall be assigned to the default group EDP epoch, which ID is 0, when the STA associates to the CPE BSS and both the AP and STA support group EDP epoch. The group EDP epoch setup is described in 10.71.2.4 (Group EDP epoch setup).

A CPE STA may subsequently send a EDP epoch request to join a specific group EDP epoch or the CPE STA can request the AP to start a new group EDP epoch that matches the EDP epoch settings specified by sending an EDP epoch setting protected action request frame.

The AP shall respond with an EDP epoch setting protected action response frame, accepting or rejecting the request.

A CPE STA may leave the group EDP epoch by sending EDP epoch setting protected action request frame.

**10.71.2.3 Group EDP epoch**

*Instructions to the 802.11bi Editor: Please add this clause and renumber the following clauses.*

A CPE AP advertises group EDP epoch support in Beacon and Probe Response frames by setting value 1 to the Group EDP Epoch Supported field of the Extended RSN Capabilities field.

A CPE non-AP STA advertises group EDP epoch support in (Re)-Association Request frames by setting value 1 to the Group EDP Epoch Supported field of the Extended RSN element.

Group EDP Epoch support is mandatory for the CPE AP and the CPE STA.

A CPE AP advertises group EDP epochs by sending an unicast protected action frame containing an Enhanced Group Privacy Availability element for each relevant group EDP epoch in the BSS. A CPE AP shall advertise group EDP epochs to each non-AP STA that joins the BSS and may advertise group EDP epochs when significant changes have affected one or more groups.

A CPE STA may be a member of only one group EDP epoch at a time.

A CPE STA may request to join a group EDP epoch by sending an EDP epoch setting protected action request frame, containing the group ID that the STA wishes to join.

The AP responds with an EDP epoch setting protected action response frame, accepting or rejecting the request.

A CPE STA may leave the group EDP epoch by sending EDP epoch setting protected action request frame.

If a CPE STA is a member of a group EDP epoch, the STA and AP shall anonymize the selected OTA fields of the individually addressed frames according to group epoch settings as defined in 10.71.3 (Establishing frame anonymization parameter sets), 10.71.4 (Frame anonymization transmitting functions), 10.71.5 (Frame anonymization receiving functions) and 10.71.6 (Frame anonymization and AID). An overview of the group EDP epoch is shown in Figure XX (Overview of anEDP epoch).



**Figure XX – Overview of group EDP epoch.**

## 10.71.2.4 Group EDP epoch setup

*Instructions to the 802.11bi Editor: Please add this clause and renumber the following clauses.*

A CPE STA signals support for group EDP epoch by setting the Group EDP Epoch Supported field in the RSNXE in the (Re-)Association Request Frame.

A group EDP epoch has a BSS Specific Epoch Number and STA Specific Epoch Number that are signaled to the STA at the group EDP epoch setup. The BSS Specific Epoch Number is an input parameter of the BSS specific offset calculation. The STA Specific Epoch Number is an input parameter of the STA specific offset calculation.

If a CPE AP supports group EDP epoch and receives a (Re)Association Request frame with the Group EDP Epoch Supported field set, then the AP shall assign the CPE STA to the default group EDP Epoch if association succeeds.

The protected Association Response frame provides the default group EDP information in the EDP Epoch Settings field of the Group Enhanced Privacy Element.

After the STA has associated, the CPE AP sends to the CPE STA one or more protected action frames that include the Enhanced Group Privacy Availability Element, to signal the list of group EDP epochs supported in the BSS. The STA may request to join another group EDP epoch, or provide EDP epoch settings, by sending a STA Specific Epoch Setting action frame.

## 10.71.2.6 Epoch boundaries

*Instructions to the 802.11bi Editor: Please add this clause and renumber the following clauses.*

CPE STAs anonymize their EDP OTA fields of individually addressed frames at the beginning of each new epoch. The next epoch boundary occurs at a Next Epoch Start Time defined in the EDP Epoch Setting field of the Group Enhanced Privacy element of the (re)-association response frame or the EDP epoch setting action response frame. The Epoch Duration field of the same fields and frames defines the interval of the following group EDP epochs.

Each EDP epoch has the Group and STA specific Epoch Number, which values are increased by 1 for each epoch.

A CPE STA and CPE AP may calculate the anonymized OTA values before the EDP epoch during which they are to be used.

At the start of the new EDP epoch, the new anonymization parameters are used to anonymize the selected OTAfields of all transmitted individually addressed frames.

The CPE STA and CPE AP shall begin to accept individually address frames that use the new anonymization parametersfor a *dot11EpochTransitionTime* before the start of new epoch. The CPE STA and CPE AP shall accept individually addressed frames with the old anonymization parameters for a *dot11EpochTransitionTime* after the start of the new epoch. The rules of clause 10.71.2.1( apply for frame retransmissions and acknowledgments.

The MAC Header parameters of the individually addressed frames are anonymized as defined in 10.71.3 (Establishing frame anonymization parameter sets), 10.71.4 (frame anonymization transmitting functions) and 10.71.5 (frame anonymization receiving functions).

## 10.71.2.8 OTA address collision avoidance

*Instructions to the 802.11bi Editor: Please add the following new clause.*

A CPE AP may calculate that the OTA MAC address that a CPE STA is bound to use in a subsequent epoch may cause a collision with the OTA MAC of other CPE STA(s). When such collision is detected, the AP shall send to the CPE STA an otaMAC collision warning action frame before the collision epoch, instructing the STA to apply the signaled STA specific Epoch Number to avoid address collision.

NOTE, the STA participating to an EPD epoch applies the BSS-specific AID offset to OTA AID, when the Epoch Number changes.

## 9.4.2.240 RSNXE

*Instructions to the 802.11bi Editor: Please add the bit 8 and 9 text to the clause and remove the bits from the reserved bits.*

|  |  |  |
| --- | --- | --- |
| **Bit** | **Information** | **Notes** |
| 8 | Group EDP Epoch Supported | A STA sets the Group Epoch Support field to 1 when dot11GroupEpochActivated is true and sets it to 0 otherwise.  |
|  |  |  |

## 9.6.38.4 Group Enhanced Privacy (EP) element

*Instructions to the 802.11bi Editor: Please add the following new clause. Please renumber the new clause and other clauses accordingly.*

The Group Enhanced Privacy (EP) element signals epoch parameters in protected action frames. The Group EP element signals the default privacy epoch parameters in the protected Association Response frame. The Group EP element signals specific group epoch settings in STA Specific Setting Epoch action frames.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Element Id | Length | Element Id Extension  | EDP Epoch Settings |
| Octets:  | 1 | 1 | 1 | 0 or 12 |

## Figure -XX Group Enhanced Privacy (EP) element

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

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Reserved | Reserved | Group Epoch Interval  | Next Epoch Start Time  | Time Range | Reserved | Epoch Duration | Current Epoch Number |
| Bits: | 11 | 11 | 14 | 64 | 16 | 4 | 8 | 48 |

## Figure XX – EDP Epoch Settings field

The EDP Epoch Settings field defines the anonymization mode of the STA.

The Smallest Anonymized AID field signals the smallest AID value that is periodically anonymized.

The AID Range field signals the number of AID values that are periodically anonymized.

|  |  |  |
| --- | --- | --- |
|  | Group Epoch Interval Unit | Group Epoch Interval |
| Bits: | 3 | 11 |

## Figure XX – Group Epoch Interval length field

The Group Epoch Interval field contains the duration of the EDP epoch. The 3 MSBs signal the Group Epoch Interval Unit, as shown in table XX. The 11 LSBs signal the duration of each epoch, in units specified on the Group Epoch Interval Units.

Table XX: Group Epoch Duration Units and epoch durations

|  |  |  |  |
| --- | --- | --- | --- |
| Group Epoch Interval Unit field value | Group Epoch Interval Unit  | Min Epoch Duration  | Max Epoch Duration (approx.) |
| 0 | 1000 s | 16 min 40 s | 23 d 16 h 36 min 40 s |
| 1 | 1 s | TBD but not shorter than 1s | 34 min 7 s |
| 2 | Reserved | N/A | N/A |
| 3 | Reserved | N/A | N/A |
| 4 | Reserved | N/A | N/A |
| 5 | Reserved | N/A | N/A |
| 6 | Reserved | N/A | N/A |
| 7 | Reserved | N/A | N/A |

The Next Epoch Start Time field signals the start time of the next EDP epoch, using the reference start time GT0 of the EDP Epoch indicated in the “Start Time” subfield of the EDP Epoch Sequence parameters element.

The effective start time GET of the EDP Epoch is computed according to the formula:

GET = GT0 + ∆IT

where ∆IT = PRF-128\64(GTK\*, “ERCM”, GT0) mod (RandTR)

and where:

PRF-Length is the pseudorandom function defined in 12.7.1.2

GT0 is the value indicated in the Start Time field of the advertised EDP Epoch Sequence parameters element

RandTR is the value indicated in the Time Range field of the advertised EDP Epoch Sequence parameters element

GTK\* is a key derived from GTK, where GTK\* = KDF-Hash-256(GTK, “EDP”, BSSID)

At any point of time, for the next EDP Epoch, the start time is computed according to the formula:

GETn+1 = GTn+1 + ∆IT

∆IT = PRF-128\64(GTK\*, “ERCM”, GTn+1) mod (RandTR)

With:

GTn+1 =GTn+ GEI

Or

n = ⌊(TSF – GT0) / GEI⌋

GTn+1 =GT0+ (n+1) x GEI

Where:

n is the current iteration of the sequence.

TSF is the current value of the internal TSF counter of the receiving link.

GT0 is the value indicated in the Start Time field of the advertised EDP Epoch Sequence parameters element

RandTR is the value indicated in the Time Range field of the advertised EDP Epoch Sequence parameters element

GEI is the value indicated in the Interval field of the advertised EDP Epoch Sequence parameters element

GTK\* is the key derived from GTK.

The time range field is the range used by the stations to determine a random delay added to the EDP Epoch reference start time.

The Epoch Duration field indicates the number of EDP Epochs left to run, after the current epoch finishes. The length of the Duration field is 1 octet. The settings of the value in the Duration field are defined in Table 9-bbb

**Table 9-bbbb - Duration field values**

|  |  |
| --- | --- |
| Value | Meaning |
| 0 | Undetermined (unlimited) duration |
| 1 | The duration corresponds to one more iteration  |
| N | The duration corresponds to N more iterations between [1..255] |

The Current Epoch Number field signals the current epoch number, modulo 48

## 9.6.38.6 Enhanced Group Privacy Availability Element (EGPA) element

*Instructions to the 802.11bi Editor: Please add the following new clause. Please renumber the new clause and other clauses accordingly.*

The Enhanced Group Privacy Availability Element signals the list of EDP epoch groups supported in the BSS, in addition to the default group.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Element Id | Length | Element Id Extension  | Group Count | Group ID | Length | EDP Epoch Settings  | Number of Participating STAs |
| Octets:  | 1 | 1 | 1 | 1 | m \* 1 | m \* 1 | m \* 12 | 0 or m \* 3 |
|  |  |  |  |  |  | $$m\geq 1$$ |

## Figure -XX Enhanced Group Privacy Availability Element

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

The Group Count field indicates the number of groups signaled in the EGPA element, each group described with a tuple Group ID, EDP Epoch Settings and Number of Participating STAs fields. The AP advertises some or all of the configured groups.

The EPGA element contains m ( m = 1 or more) tuples of Group ID field, EDP Epoch Settings field and Number of Participating STAs field.

The Group ID field signals an identifier of the group EDP Epoch. Value 0 indicates the default group. Value 255 is reserved.

The EDP Epoch Settings field defines the parameter of this group EDP Epoch, as described in 9.6.38.4.

The Participating STAs field is optional. When present, the field signals an indication of the number of STAs currently participating to this group EDP epoch.

|  |  |  |
| --- | --- | --- |
|  | Participating STA Count | Participating STA Percentage |
| Octets: | 2 | 1 |

## Figure -XX Number of Participating STAs field

The first two octets of the Participating STA Count field represent an indication of the number of STAs participating to the signaled group. The third octet values, in the range of 0 to 100, represent an indication of the percentage of the associated STAs participating to the signaled group. Values 101-255 are reserved.

## 9.6.38.7 otaMAC collision warning element (oMCWE)

*Instructions to the 802.11bi Editor: Please add the following new clause. Please renumber the new clause and other clauses accordingly.*

The otaMAC collision warning element is present in the otaMAC Collision Warning protected action frame and signals that an otaMAC address expected to be used by the receiving STA in an upcoming epoch is calculated to collide with another STA.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Element Id | Length | Element Id Extension  | Collision Status | Colliding Epoch  | STA Specific Epoch Number Offset |
| Octets:  | 1 | 1 | 1 | 1 | 1 | 1 |

## Figure -XX otaMAC collision warning element

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

The Collision Status field indicates the intent of the oMCWE. The AP shall set the Collision Status to 1 when signaling to a STA the risk of otaMAC collision in a future epoch. The STA shall set the Collision Status to 0 when responding to an AP otaMAC Collision Warning action frame, acknowledging the warning and indicating that the STA will skip epoch parameters as suggested by the AP. The STA shall set the Collision Status to 2 when responding to an AP otaMAC Collision Warning action frame, and rejecting the AP suggestions.

The Colliding Epoch field indicates the future epoch at which MAC collision is likely to occur. The epoch is indicated in units of epochs. A value of 0 indicates the current epoch.

The STA Specific Epoch Number Offset field indicates the Epoch count that the STA skips to mitigate the otaMAC address collision. Thus, if the current epoch is 0, the colliding epoch is m, indicating that the collision is expected to occur m epochs after the current epoch, and if the STA Specific Epoch Number Offset is n, then when the epoch is m, the CPE STA is expected to use the STA Specific value for Epoch Number m+n. The following epoch m+n+1 will use STA Specific values of epoch ID m+n+1 unless the AP also signals a collision warning for epoch m+n+1. Value 0 is reserved.

## 9.6.38.8 EDP epoch setting element

*Instructions to the 802.11bi Editor: Please add the following new clause. Please renumber the new clause and other clauses accordingly.*

The EDPepoch setting element is present in the STA Specific Epoch Setting action frame, and indicates a request or a response for EDP epoch settings.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Element Id | Length | Element Id Extension  | Dialog Token | Dialog Value | Target Group ID | EDP Epoch Settings  |
| Octets:  | 1 | 1 | 1 | 1 | 1 | 1 | 0 or 12 |

## Figure -XX EDPepoch setting element

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

The Dialog Token field is used for matching action responses with action requests.

The Dialog Value field indicates the status of the frame carrying the element. A value of 0 is reserved. The field shall be set to 1 when the element is carrying a request from a CPE STA to a CPE AP to join the Group EDP specified in Target Group ID if the Group ID is in the range 0-254 or to initiate an EDP epoch if the Group ID is 255. The field shall be set to 2 when the element is carrying a response from the CPE AP to the CPE STA accepting the EDP epoch requested by the CPE STA. The field shall be set to 3 when the element is carrying a response from the CPE AP to the CPE STA rejecting the EDP epoch requested by the CPE STA. The field shall be set to 4 when the element is carrying a request from the CPE STA stating its intention not to participate to any periodic group epoch. The field shall be set to 5 if the CPE STA is requesting the CPE AP to leave the Group EDP specified in Target Group ID if the Group ID is in the range 0-254 or to cancel a previously initiated EDP epoch if the Group ID is 255.

The Target Group ID field indicates the identifier for the group that the STA is requesting to join. The value 255 indicates that the STA does not request to join a particular group, but requests EDP settings.

The EDP Epoch Settings field is described in clause 9.6.38.4 (Group Enhanced Privacy (EP) element).

When the Dialog field is 1, and the group ID is in the range 0-254, the STA is requesting to join a particular group, and the EDP Epoch Settings field is not present.

When the Dialog field is 1 and the Group ID is 255, the STA does not request to join a specific group, but requests instead STA-specific parameters, and the EDP Epoch Settings field is present.

When the dialog field is 2, and the group ID is in the range 0-254, the AP accepts the STA request. The EDP Epoch Settings field is present and indicates the parameters of the group that the STA requested to join.

When the dialog field is 2, and the group ID is 255, the AP accepts the EDP settings requested by the STA. The EDP Epoch Settings field is present. TheGroup Epoch and Next Epoch fields indicate the epoch parameters allocated by the AP.

When the dialog field is 3, the AP rejects the STA requests. The group ID value is reserved and the EDP Epoch Settings field is not present.

When the dialog field is 4, the STA is requesting to not participate to any group. The group ID is reserved and the EDP Epoch Settings field is not present.

When the dialog field is 5, the STA is requesting to not participate to a specific group. The EDP Epoch Settings field is not present.

|  |  |  |  |
| --- | --- | --- | --- |
| Dialog | Group ID | Context | EDP Epoch Settings |
| 1 | 0-254 | STA is requesting to join a particular group | Not Present |
| 1 | 255 | STA is requesting STA\_specific parameters | Present |
| 2 | 0-255 | AP is accepting STA request | Present |
| 3 | Reserved | AP is rejecting STA request | Not Present |
| 4 | Reserved | STA is requesting to not participate to any group | Not Present |
| 5 | 0-255 | STA is requesting not to participate to a specifc group | Not Present |
|  |  |  |  |

*Instructions to the 802.11bi Editor: Please add the new MIB parameters.*

dot11GroupEpochActivated OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-write

STATUS current

DESCRIPTION

“

This is a control variable.

It is written by an external management entity.

This attribute, when true, indicates that the station capability of group epochs is enabled. False indicates that the capability is present but is disabled.”

DEFVAL { false }

dot11EpochTransitionTime OBJECT-TYPE

SYNTAX Unsigned32 (1..100)

UNITS “0.1 milliseconds”

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"This is a control variable.

It is written by an external management entity or the SME. Changes take effect as soon as practical in the implementation.

This attribute indicates the duration when the STA receives individually addressed frames that use the anonymization parameters before an EPOCH boundary or the new anonymization parameters after the EPOCH boundary."

DEFVAL {100}