IEEE P802.11
Wireless LANs

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| Periodic 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.

## 10.71.2.1 Introduction

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

## 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.

Two EDP epochs are defined:

## — An individual(#Ed) EDP epoch(#Ed) sequence request is initiated by a non-AP MLD and the associated AP MLD shall send a response. The EDP epoch(#Ed) parameters of an individual EDP epoch(#Ed) are negotiated by a non-AP MLD with its associated AP MLD as defined in 10.71.2.2 (Individual EDP epoch #Ed)). The non-AP MLD applies the negotiated EDP epoch(#Ed) parameters(#Ed) of the individual(#Ed) EDP epoch(#Ed) to determine the(#Ed) corresponding EDP epoch(#Ed) sequence of one or more EDP epoch(#Ed) start times.

## — A group(#Ed) EDP epoch(#Ed) sequence is initiated automatically by an AP MLD advertising the EDP epoch(#Ed) support in beacons and probe responses. All CPE STAs joining the BSS are placed by default in a group called automatic EDP epoch group. A CPE STA can request to leave this group and/or join a different group at any time.

## The AP MLD advertises the EDP ecpoch (#Ed) parameters as defined in 10.71.2.3 (Group EDP epoch (#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 participating OTA AIDs and MAC Headers of individual 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).

At the beginning of the new epoch, the CPE STA participating to individual or group epoch changes its AID following the AID anonymization scheme provided by the AP. A CPE STA using a group EDP epoch may request that CPE AP assigns new AID value for it. The AID assignment is described in clause 10.71.6 (Frame anonymization and AID). Group EDP epoch uses BSS specific AID offset at the beginning of the new epoch to anonymize the AID as described in clause 10.71.2.4.3 (OTA AID anonymization with BSS specific offset).

**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 Individual EDP epoch**

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

A CPE AP advertises support for individual epoch by setting value 1 to the Individual Epoch Supported field of the Extended RSN element of the Beacon and Probe Response frames it transmits.

A CPE non-AP STA advertises support for individual epoch by setting value 1 to the Individual Epoch Supported field of the Extended RSN element of the (Re)-Association Request frames it transmits.

Individual EDP Epoch support is optional for the CPE AP and the CPE STA.

When the individual EDP epoch is setup, the STA and AP shall anonymize the AID of the STA and the MAC Header parameters of the individually addressed frames according to STA-specific 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).

**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 support for group epoch in Beacon and Probe Response frames it transmits by setting value 1 to the Group Epoch Supported field of the extended RSN Capabilities field.

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

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

A CPE non-AP STA that supports group epochs and associates to a CPE BSS that supports group EDP epochs is automatically assigned to the default group, whose ID is 0. The group EDP epoch setup is described in 10.71.2.4(Group EDP epoch setup).

A CPE AP advertises periodically its groups EDP epochs through ~~a broadcast or~~ unicast protected action frame contiaining an Enhanced Group Privacy Availability element for each group EDP epoch in the BSS. A CPE AP advertises its group~~s~~ EDP epochs at least each time a new non-AP STA joins the BSS ~~and each time there is~~ or a parameter change in one of the groups.

A CPE STA can join or leave any one of the groups EDP advertised by the CPE AP by sending to the AP a STA-specific epoch setting protected action request frame, containing the group ID that the STA wishes to join or leave. A STA can be an active member of only one group at a time.

The AP responds with a STA-specific epoch setting protected action response frame, accepting or rejecting the request.

If a CPE STA participates to a group EDP epoch, including the default one, the STA and AP shall anonymize the AID of the STA and the MAC Header parameters 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).

Periodic epochs allow CPE AP and CPE STA to anonymize the OTA AID of the CPE STA and the OTA MAC Headers of individually addressed frames between the CPE AP and the CPE STA. The OTA AID anonymization uses BSS specific offset as described in 10.71.2.7 (OTA AID anonymization with BSS specific offset). An overview of the group EDP epoch is shown in Figure XX (Overview of automatic EDP epoch).

 

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

Pseudorandom offset: TBD.

## 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 the support for group EDP epoch by setting the Group EDP supported field in the Enhanced Privacy Capability Element in the (Re-)Association Request Frame.

Group Epoch has a BSS specific Epoch Number and STA specific Epoch Number. The BSS specific Epoch Number is used to calculate offset for BSS specific parameters. The STA specific Epoch Number is used to calculate offset for STA specific parameters. The group Epoch Number value and STA specific Epoch Number are signaled to the STA at the group setup signaling.

If a CPE AP that supports group EDP epoch receives a (Re)Association Request frame with the Group EDP Supported field of the Enhanced Privacy Capabilities element, then the AP shall assign the CPE STA to the default group EDP Epoch if association succeeds. The CPE AP shall assign an AID value to the associating CPE STA on the range that is applied only for the automatic EDP epoch STAs as described in 10.71.2.7 (OTA AID anonymization with BSS specific offset).

In the M3 frame of the 4-way handshake, the CPE AP provides the group EDP Epoch field defined in the Enhanced Privacy Element to signal the default group EDP information to the STA and the subsequent AIDs to be used by the EDP STA.

The Group EDP Epoch field signals the smallest anonymized AID, the AID range that the STA should use within the default group. The Group EDP Epoch field also indicates the duration of each epoch, and the start time of the next epoch.

## 10.71.2.5 Individual EDP epoch setup

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

A CPE STA signals the support for individual EDP epoch by setting the STA-Specific Setting Supported field in the Enhanced Privacy Capability Element in the (Re-)Association Request Frame.

The AP announces the default group epoch interval in the the Enhanced Privacy element in the 4-way handshake M3 frame. Any time after receiving that frame, a CPE STA that does not wish to use the default group parameters sends to the AP a STA-specific Epoch Setting action request frame, expressing the epoch duration requested by the STA.

A CPE STA that does not wish to participate to any group epoch announced by the AP and does not wish to request a specific duration setting, sends to the AP a STA-specific epoch setting action request frame, with dialog field set to 4. The AP responds with acceptance or refusal of the STA request.

## 10.71.2.6 Epoch boundaries

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

All EDP epoch CPE STAs anonymize their OTA AID and OTA MAC Header fields of individually addressed frames at the beginning of each new epoch. The epoch boundary occurs at a TBTT, and a new epoch starts at an interval of one or multiple TBTT(s). Each 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 OTA AID and OTA MAC Header values before the epoch during which they are to be used.

At the start of the new epoch, the new OTA AID identifies the CPE STA, and the new OTA MAC Header offset is applied to all transmitted individually addressed frames between the CPE STA and CPE AP.

The CPE STA and CPE AP shall begin to accept individually address frames with the new OTA AID and new OTA MAC Header values a *dot11AutomaticEpochTransitionTime* before the start of new epoch. The CPE STA and CPE AP shall accept individually addressed frames with the old OTA AID and old OTA MAC Header values for a *dot11AutomaticEpochTransitionTime* after the start of the new epoch.

The MAC Header parameters of the individually addressed frames between the STA and the AP 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).

## 10.71.2.7 OTA AID anonymization with BSS specific offset

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

The AP shall reserve a range of AID values for a group EDP epoch. The AP shall assign to a non-AP CPE STA joining a group EDP epoch an AID value from the corresponding group EDP epoch specific range.

The STAs that participate to the group EDP epoch anonymize their OTA AID values within the range by using the following formula:

OTA AID = Smallest\_anonymized\_AID + ((AID\_assigned + AID\_Offset) Modulo (AID

\_range\_size)), where:

* The smallest anonymized AID value and AID range size are signaled in the Enhanced Privacy element of the (Re)Association Response frame.
* The AID\_Offset is calculated with a BSS specific key and by using the Epoch Number in the offset calculation. The exact algorithm to calculate the AID\_Offset is TBD.

## 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 determination is made, the AP shall send to the CPE STA an otaMAC collision warning action frame before that target epoch, instructing the STA to apply the signaled 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 Epoch Support | A STA sets the Group Epoch Support field to 1 when dot11GroupEpochActivated is true and sets it to 0 otherwise.  |
| 9 | Individual Epoch Support | A STA sets the Individual Epoch Support field to 1 when dot11IndividualEpochActivated is true and sets it to 0 otherwise. |

## 9.6.38.4 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 Enhanced Privacy (EP) element signals epoch parameters in protected action frames. The EP element signals the default privacy epoch parameters in the M3 frame of the 4-way handshake. The EP element signals specific group, or STA-specific epoch settings in STA Specific Setting Epoch action frames.

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

## Figure -XX Enhanced Privacy (EP) element

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Smallest Anonymized AID | AID Range | Group Epoch Duration | Next Epoch | Reserved | Current Epoch Number |
| Bits: | 11 | 11 | 14 | 11 | 1 | 48 |

## Figure XX – Group EDP Epoch field

The Group EDP Epoch 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 Duration Unit | Group Epoch Duration |
| Bits: | 3 | 11 |

## Figure XX – Group Epoch length field

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

Table XX: Group Epoch Duration Units and epoch durations (supposing a default TBTT duration of 102.4 ms)

|  |  |  |  |
| --- | --- | --- | --- |
| Group Epoch Duration Unit field value | Group Epoch Duration Unit in number of TBTTs | Epoch Duration Unit in time (w/default TBTT dur.) | Max Epoch Duration with the Duration Unit (approx.) |
| 0 | 0.05 | 5.12 ms | 10.5 s |
| 1 | 0.5 | 51.12 ms | 1 min 45 s |
| 2 | 5 | 512 ms | 17 min 28 s |
| 3 | 50 | 5.12 s | 2 h 54 min 41 s |
| 4 | 500 | 51.2 s | 1 d 5 h 6 min 46 s |
| 5 | 5000 | 8 min 32 s | 12 d 3 h 7 min 44s |
| 6 | Reserved | N/A | N/A |
| 7 | Reserved | N/A | N/A |

The Next Epoch field signals, in Group epoch length units, the start time of the next EDP epoch.

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 | Group EDP Epoch  | Number of Participating STAs |
| Octets:  | 1 | 1 | 1 | 1 | m \* 1 | m \* 12 | 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, Group EDP Epoch and Number of Particpating STAs fields.

The EPGA element contains m ( m = 1 or more) tuples of Group ID field, Group EDP Epoch 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 group EDP Epoch field defines the parameter of this group EDP Epoch, as described in 9.6.38.4.

The Participating STAs field signals the number of STAs currently participating to this group EDP

epoch and that have not requested STA-specific settings.

|  |  |  |
| --- | --- | --- |
|  | 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 the count of STAs participating to the signaled group. The third octet values, in the range of 0 to 100, represent 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 when the STA Specific Epoch number is m, 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 ~~otaMAC~~ value for Epoch Number m+n. The following epoch m+n+1 will use STA Specific ~~otaMAC~~ 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 STA-specific 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 STA-specific epoch setting element is present in the STA Specific Epoch Setting action frame, and indicates a request or a response for STA-specific epoch settings.

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

## Figure -XX STA-specific epoch setting element

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

The Dialog 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 individual 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 STA-specific 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 STA-specific 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 individual 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 STA-specific settings.

The Group EDP Epoch field is described in clause 9.6.38.4 (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 Group EDP Epoch 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 Group EDP Epoch field is present. The Smallest Anonymized AID and the AID range fields are reserved in that case, and the Group Epoch and Next Epoch fields indicate the epoch parameters requested by the STA.

When the dialog field is 2, and the group ID is in the range 0-254, the AP accepts the STA request. The Group EDP Epoch 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 STA-specific settings requested by the STA. The Group EDP Epoch field is present. The Smallest Anonymized AID and the AID range fields indicates the AID scheme for the STA, and the Group 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 Group EDP Epoch 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 Group EDP Epoch field is not present.

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

|  |  |  |  |
| --- | --- | --- | --- |
| Dialog | Group ID | Context | Group EDP Epoch |
| 1 | 0-254 | STA is requesting to join a particular group | Not Present |
| 1 | 255 | STA is requesting STA\_specific parameters | Present |
| 2 | 0-254 | AP is accepting STA request | Present |
| 2 | 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.*

dot11IndividualEpochActivated 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 individual epochs is enabled. False indicates that the capability is present but is disabled.”

DEFVAL { false }

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 }

dot11AutomaticEpochTransitionTime 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 frames that include one of the two OTA AID values and individually addressed frames that include one of the two MAC Header values."

DEFVAL {100}