IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Proposed Text for incorporating MAAD and IRM into TGbh Draft 0.2 | | | | |
| Date: 2022-07 | | | | |
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Abstract

Proposed text for the MAAD MAC scheme as per 22/0737r2 and IRM 22/0894r0

Device ID indication, MAAD and IRM will then be covered.

IRM support is to accomodate STAs that prefer to allocate their MAC addresses rather than have the AP allocate.

AP and STA can advertise support for any, combinations or all three. No selection, computations or calculations are required. Recommended that AP supports combination or all as per its Use Case or upper layer application. STA should support either device ID and MAAD, or device ID and IRM, or all three.

Device ID – AP sends ID in msg 3, STA sends ID back in msg 2 on every associaition

MAAD – AP sends MAAD MAC in msg 3 on every association, STA uses MAAD MAC as TA on next association.

IRM – STA sends IRMA in msg 2 on every association. STA uses the IRMA as TA on the next association.

If AP sees IRMA in msg 2, AP does not send MAAD in msg 3.

See 22/0908r1 for detailed discussion on how the schemes simply co-exist.

Introduction:

The MAAD scheme uses an ID allocated by an AP during a previous RSN association as the TA for a new association. The TA is changing every association.

The IRM scheme uses an ID allocated by the STA during a previous RSN association as the TA for a new association. The TA is changing every association

The following provides the instructions for inserting the new text into Draft 0.2.

Instructions:

802.11 bh Draft 0.2 is base

*Add the following definitions t o 3.2*

**identifiable random medium access control (MAC) (IRM)**: a scheme where a non-AP STA uses identifiable random medium access control (MAC) addresses (IRMA) to prevent third parties from tracking the non-AP STA while still allowing trusted parties to identify the non-AP STA.

**identifiable random medium access control (MAC) address (IRMA):** a randomized medium access control (MAC) address used by a non-AP STA using identifiable random medium access control (MAC) (IRM).

*Add following Acronym to 3.4.*

MAAD MAC Address Designation

*At 4.5.4.10, edit last sentence to read*

Such a STA, when reconnecting to a network, can opt-in to exchange a device identifier that allows the network to recognize the device and/or use a MAC address that has been allocated by the network or the STA, whilst still protecting the information from third parties.

***Clause 6.3***

***We will need an “MLME-RCM” primitive so that the SME can instruct the MLME to set up which schemes (device ID, MAAD, IRM) the STA will support. Work in ARC and TGme will probably change the way this is written. The primitive will consist of a single MLME-RCM.request.***

*At 9.3.3.5 Association Request frame format*

*Insert new row in Table 9-62 Association Request frame body P23*

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <ANA> | Device ID | The Device ID element is optionally present when using FILS authentication; otherwise, it is not present. |
| <ANA> | MAAD | The MAAD element is optionally present when using FILS authentication; otherwise, it is not present |
| <ANA> | IRM | The IRM element is optionally present when using FILS authentication; otherwise, it is not present |

*At 9.3.3.6 Assocaition Response frame format*

*Insert new row in Table 9-63 Association Response frame body P1031*

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <ANA> | Device ID | The Device ID element is optionally present when using FILS authentication; otherwise, it is not present. |
| <ANA> | MAAD | The MAAD element is optionally present when using FILS authentication; otherwise, it is not present |
| <ANA> | IRM | The IRM element is optionally present when using FILS authentication; otherwise, it is not present |

*Insert new row in Table 9-64 Reassociation Request frame body*

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <ANA> | MAAD | The MAAD element is optionally present when using FILS authentication; otherwise, it is not present |
| <ANA> | IRM | The IRM element is optionally present when using FILS authentication; otherwise, it is not present |

*Insert new row in Table 9-65 Reassociation Response frame body*

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <ANA> | MAAD | The MAAD element is optionally present when using FILS authentication; otherwise, it is not present |
| <ANA> | IRM | The IRM element is optionally present when using FILS authentication; otherwise, it is not present |

*At 9.4.2.1 Insert new row in Table 9-128 Element IDs P23*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Element | Element ID | Element ID Extension | Extensible | Fragmentable |
| Device ID (see 9.4.2.x (Device ID element)) | 255 | <ANA> | No | No |
| MAAD (see 9.4.2.xx MAAD element) | 255 | <ANA> | No | No |
| IRM (see 9.4.2.xxx IRM element) | 255 | <ANA> | No | No |

*At 9.4.2.241 Insert new row in Table 9-363 Extended Capabilities field, P24*

|  |  |  |
| --- | --- | --- |
| **Bit** | **Information** | **Notes** |
| <ANA> | Device ID support | The STA sets the Device ID Support field to 1 to indicate support for Device ID indication. Otherwise, the STA sets the Device ID field to 0. |
| <ANA> | MAAD Capability | A STA sets MAAD Capability subfield to 1 to indicate support for MAAD and sets to 0 if MAAD is not supported. |
| <ANA> | IRM Capability | A STA sets IRM Capability subfield to 1 to indicate support for MAAD and sets to 0 if IRM is not supported. |

*Insert following subclauses after 9.4.2.296a “Device ID element” P 24*

9.4.2.x MAAD element

The MAAD element contains a MAAD MAC address. The format of the MAAD element is shown in Figure 9-y.

|  |  |  |  |
| --- | --- | --- | --- |
| Element ID | Length | Element ID Extension | MAAD MAC |

Octets 1 1 1 6

**Figure 9-y MAAD element**

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

The MAAD MAC field is a 48-bit MAC address.

**9.4.2.xxx Identifiable Random MAC (IRM) element**

The IRM element is used by a non-AP STA that is using an IRMA. The format of the IRM element is defined in Figure 9–yyy.

|  |  |  |  |
| --- | --- | --- | --- |
| Element ID | Length | Element ID Extension | IRMA |

Octets: 1 1 1 1

**Figure – 9-yyy – IRM element format**

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

The IRMA field is a 48-bit MAC address

**12. Security**

*Add the following new subclause after 12.2.10 (i.e., immediately before 12.3)*

**12.2.11 Mitigation of random and changing changing MAC address**

To mitigate tracking and traffic analysis, a non-AP STA may randomly change its MAC address (see 4.5.4.10). For some services, however, it may be desirable to the user that the non-AP STA is identified by the AP and network services. Device ID indication, MAAD, and IRM may be used to identify the non-AP STA whilst still being unidentifiable to a third party.

When using device ID indication, an AP may provide a device ID, contained in a device ID KDE in message 3 of the 4-way handshake, to a non-AP STA and the non-AP STA may provide that same device ID, in a device ID KDE in message 2 of the 4-way handshake, to any AP in the same ESS to allow the network to recognize the same non-AP STA when it returns to the ESS even if it changes its MAC address.

When using MAAD, an AP may provide a random MAC address (MAAD MAC address) contained in a MAAD KDE in message 3 of the 4-way handshake, to a non-AP STA when it associates, and the non-AP STA may then use that MAAD MAC address as its TA when associating the next time to that ESS or AP. Hence, that AP or ESS can also recognize that non-AP STA pre-association.

When using IRM, a non-AP STA, when associating, may provide a random identifiable random MAC address (IRMA), contained in an IRMA KDE in message 2 of the 4-way handshake, to an AP. The non-AP STAA may then use that IRMA as its TA when associating the next time to that ESS or AP. Hence, that AP or ESS can also recognize that non-AP STA pre-association.

A non-AP STA and an AP may indicate support for device ID indication, MAAD and IRM either individually or in combination. An MLME-RCM.request may be used to set which scheme(s) the STA supports. A non-AP STA and an AP may indicate support for device ID indication, MAAD and IRM either individually or in combination.

MAAD and IRM can not be used at the same time. If the AP and non-AP STA indicate support for MAAD and IRM then if the non-AP STA includes an IRMA KDE in EAPOL Key-message 2/4, then the AP shall not include a MAAD KDE in EAPOL-Key message 3/4.

**12.2.11.1 Device ID indication**

~~An AP may provide an identifier to a non-AP STA and the non-AP STA may opt-in to providing that identifier to any AP in the same ESS to allow the network to recognize the same non-AP STA when it returns to the ESS even if it changes its MAC address. Exchanges of this identifier information are protected from third parties to limit the tracking capability to the APs in an ESS~~.

A non-AP STA indicates support for this capability in the Device ID Support subfield in the Extended RSN Capabilities field (see 9.4.2.241 (RSN Extension Element)). An AP shall not send an identifier to a non-AP STA that does not indicate support for this capability.

When using FILS authentication, the non-AP STA sends the identifier, if it has one and opts-in to using it, in the Association Request frame and the AP sends a new identifier in the Association Response frame. When using FT, the non-AP STA sends the identifier, if it has one and opts-in to using it, during the initial mobility domain association the EAPOL-Key message 2/4 and the AP sends a new identifier in the EAPOL-Key message 3/4; the identifier or a new identifier are not exchanged during the FT protocol reassociations within the same ESS. For other cases, the non-AP STA sends the identifier, if it has one and opts-in to using it, during the initial 4-way handshake in the EAPOL-Key message 2/4 and the AP sends a new identifier in the EAPOL-Key message 3/4. When the non-AP STA sends the opaque identifier, it shall send the most recently received value from an

AP in the ESS without modification.

**12.2.11.2 MAC Address Designation (MAAD) operation**

A STA advertises support for MAAD by setting the MAAD Capability subfield to 1 in the Extended Capabilites element in Probe Response, Association Response and Reassociation Response frames.

Each time the non-AP STA associates to the AP/ESS, it receives a new MAAD MAC address during the RSN association. The non-AP STA may then use that MAAD MAC address as its TA the next time it probes or requests association to that same AP/ESS.

When the associating non-AP STA advertises support for MAAD, the AP may allocate a new MAAD MAC address to the non-AP STA by including a MAAD KDE in EAPOL-Key message 3/4, or, when using FILS authentication, including the MAAD element in the Association Response frame.

The non-AP STA should store that newly allocated MAAD MAC as an identifier for that AP/ESS. The non-AP STA then may use that allocated MAAD MAC address as its TA when it next associates to that same AP or another AP in the same ESS. In so doing, the AP/ESS will identify the non-AP STA. When reassocating to the same AP or another AP in the same ESS, the non-AP STA uses the MAAD MAC address that it used for the association.

Note 1: Allocating a new MAAD MAC during each association ensures that the non-AP STA will use a different TA for each association and hence that non-AP STA is unidentifiable to a third party.

The MAAD MAC address is a 48-bit address that is constructed from the locally administered address space (see 12.2.10). The non-AP STA may then store this address and use it as the TA in the next association request to that same AP. An AP should generate the MAAD MAC addresses on a random basis such that a returning non-AP STA cannot be identified by a third party from the TA it is using. A list of MAAD MACs and respective non-AP STAs shall be stored by the AP and used as an identifier for each non-AP STA. A non-AP STA should store the latest MAAD MAC received from a particular AP such that the next time the non-AP STA associates to that AP, the AP can identify the non-AP STA.

When a non-AP STA sends an Association Request using an allocated MAAD MAC address as the TA, to the AP that allocated that address, then that AP can identify the non-AP STA before association is started or completed. A non-AP STA should use a random MAC address when sending Probe Requests. A non-AP STA that has been allocated a MAAD MAC address, may use that address when directly probing the AP or ESS that allocated that address when directed by the AP or ESS such that, for example, the ESS may steer the non-AP STA to an appropriate AP. Such steering applications are outside of scope. A non-AP STA that has been allocated a MAAD MAC address, may use that address in an ANQP packet so that the AP that allocated that MAAD MAC may identify the non-AP STA, i.e., the non-AP STA had previously associated with that AP.

**12.2.11.3 Identifiable random MAC (IRM) operation**

A non-AP STA advertises support for IRM by setting the IRM Capability subfield to 1 in the Extended Capabilities element in Probe Request, Association Request and Reassociation Request frames. A non-AP STA includes an IRM element in its Association Request and Reassociation Request frames. An AP advertises support for IRM by setting the IRM Capability subfield to 1 in the Extended Capabilities element in its Beacon and Probe Response frames.

Each time the non-AP STA associates to an AP, the non-AP STA sends the IRMA KDE during the initial 4-way handshake EAPOL-Key message 2/4. When using FILS authentication, the IRMA is sent in the (Re)Association Request frame. When using FT, the IRMK is sent during the initial mobility domain association EAPOL-Key message 2/4, but not during the FT protocol reassociations within the same ESS. The AP shall store that IRMA as an identifier for that non-AP STA.

Note: The IRMA is changed on every association to prevent any tracking of the non-AP STA.

Each time the non-AP STA associates to an AP, the non-AP STA uses the IRMA provided at the last association to that AP as the TA. A list of IRMAs and non-AP STAs shall be stored by the AP and used as an identifier for each non-AP STA that has previously associated. A non-AP STA shall store the last IRMA provided to a particular AP such that the next time the non-AP STA associates to that AP, the AP can identify the non-AP STA.

A non-AP STA that supports IRM and that intends to be identified, associates to an AP that also supports IRM, using an identifiable random MAC address (IRMA) as its TA. An IRMA is a randomized MAC address constructed from the locally administered address space (see 12.2.10). A non-AP STA that has previously provided an IRMA to the AP, may use that IRMA as the TA in a directed probe to that AP so that the AP may identify the non-AP STA preassocation.

Note: By sending a directed probe a non-AP STA might advertise its presence to an AP before or without the need to associate.

An AP maintains a list of stored IRMAs and non-AP STAs. The AP shall use this list to identify a specific non-AP STA associated to an IRMA. An AP might delete IRMAs from its stored list for various reasons e.g., time, capacity. If, preassociation, or after association, the AP does not find a corresponding IRMA, then the AP may use the device ID so as to identify it, and then update the list of stored IRMAs and non-AP STAs with the new IRMA received from the non-AP STA during association.

When a non-AP STA sends an Association Request using an IRMA as the TA, then that AP can identify the non-AP STA before association is started or completed. A non-AP STA should use a random MAC address when sending Probe Requests. A non-AP STA may use an IRMA when directly probing the AP or ESS that knows that IRMA when directed by the AP or ESS such that the ESS may steer the non-AP STA to an appropriate AP. Such steering applications are outside of scope. A non-AP STA using an IRMA, may use that address in an ANQP packet so that the AP which nows that IRMA may identify the non-AP STA, i.e., that non-AP STA had previously associated with that AP.

* EAPOL-Key frames

*Add a new row into Table 12-10 (KDE selectors) P26 as shown below:*

|  |  |  |  |
| --- | --- | --- | --- |
| * KDE selectors | | | |
| OUI | | Data type | Meaning |
| 00-0F-AC | | <ANA> | Device ID KDE |
| 00-0F-AC | | <ANA> | MAAD KDE |
| 00-0F-AC | | <ANA> | IRMA KDE |

*Make following additions for the new KDE at the end of 12.7.2 as shown below:*

The format of the MAAD KDE is shown in Figure 12-48b (MAAD KDE format).

|  |
| --- |
| MAAD  MAC |

Octets 6

Figure 12-48b—MAAD KDE format

The MAAD MAC field contains a MAC address.

The format of the IRMA KDE is shown in Figure 12-48c (IRMA KDE format).

|  |
| --- |
| IRMA |

Octets 6

Figure 12-48c—MAAD KDE format

The IRMA field contains a MAC address.

* EAPOL-Key frame notation

*Insert following text after OCI KDE (shown for reference)*

OCI KDE is a KDE containing operating channel information

Device ID KDE is a KDE containing a device identifier

MAAD KDE is a KDE containing a MAAD MAC

IRMA KDE is a KDE containing an IRMA

* 4-way handshake
* General

*Modify 12.7.6.1 P27 as shown below:*

RSNA defines a protocol using EAPOL-Key frames called the *4-way handshake*. The handshake completes the IEEE 802.1X authentication process. The information flow of the 4-way handshake is as follows:

Message 1: Authenticator  Supplicant: EAPOL-Key(0,0,1,0,P,0,0,ANonce,0,{} or {PMKID})

Message 2: Supplicant  Authenticator: EAPOL-Key(0,1,0,0,P,0,0,SNonce,MIC,{RSNE} or {RSNE, OCI KDE} or {RSNE, RSNXE} or {RSNE, OCI KDE, RSNXE} or

{RSNE, OCI KDE, RSNXE} or {RSNE, Device ID KDE} or {RSNE, OCI KDE, Device ID KDE} or {RSNE, RSNXE, Device ID KDE} or {RSNE, OCI KDE, RSNXE, Device ID KDE} or  
{RSNE, OCI KDE, RSNXE} or {RSNE, Device ID KDE, IRM KDE} or {RSNE, OCI KDE, Device ID KDE, IRM KDE} or {RSNE, RSNXE, Device ID KDE, IRM KDE} or {RSNE, OCI KDE, RSNXE, Device ID KDE, IRM KDE} or

{RSNE, OCI KDE, RSNXE} or {RSNE, IRM KDE} or {RSNE, OCI KDE, IRM KDE} or {RSNE, RSNXE, IRM KDE} or {RSNE, OCI KDE, RSNXE, IRM KDE})

Message 3: AuthenticatorSupplicant:   
EAPOL-Key(1,1,1,1,P,0,KeyRSC,ANonce,MIC,{RSNE,GTK[N]} or   
{RSNE, GTK[N], OCI KDE} or {RSNE, GTK[N], RSNXE} or   
{RSNE, GTK[N], OCI KDE, RSNXE} or   
{RSNE, GTK[N], Device ID KDE} or {RSNE, GTK[N], OCI KDE, Device ID KDE} or  
{RSNE, GTK[N], RSNXE, Device ID KDE} or {RSNE, GTK[N], OCI KDE, RSNXE, Device ID KDE} or   
{RSNE, GTK[N], MAAD KDE} or {RSNE, GTK[N], OCI KDE, MAAD KDE} or   
{RSNE, GTK[N], RSNXE, MAAD KDE} or {RSNE, GTK[N], OCI KDE, RSNXE, MAAD KDE} or  
{RSNE, GTK[N], MAAD KDE} or {RSNE, GTK[N], OCI KDE, MAAD KDE} or   
{RSNE, GTK[N], RSNXE, Device ID, MAAD KDE} or   
{RSNE, GTK[N], OCI KDE, RSNXE, Device ID, MAAD KDE})

Message 4: Supplicant  Authenticator: EAPOL-Key(1,1,0,0,P,0,0,0,MIC,{}).

**12.7.6.3 4-way handshake message 2**

*At P 28.39 Modify 12.7.6.3 as shown below:*

* Additionally, contains an OCI KDE when dot11RSNAOperatingChannelValidationActivated is true on the Authenticator.
* Additionally, may include a Device ID KDE
* Additionally, may include an IRMA KDE.
* The RSNXE that the Authenticator sent in its (Re)Association Request frame, if this element is present in the (Re) Association Request frame that the Authenticator sent.
* 4-way handshake message 3

*At P 28 Modify 12.7.6.4 as shown below:*

* Additionally, contains an OCI KDE when dot11RSNAOperatingChannelValidationActivated is true on the Authenticator.
* Additionally, may include a Device ID KDE
* Additionally, may include a MAAD KDE.
* The RSNXE that the Authenticator sent in its Beacon or Probe Response frame, if this element is present in the Beacon or Probe Response frame that the Authenticator sent.