IEEE P802.11
Wireless LANs

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| Forwarding information |
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Abstract

This document provides suggested changes to solve a concern raised in REVmd comment collection (CID 112).

The concern is on lack of explicit description of the forwarding information validation.

R0: initial proposal presented at a TGmd conference call on October 6th.

R1: revised based on feedbacks received in the conference call.

# Comment:

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| **CID** | **PP.LL** | **Comment** | **Proposed Change** | **Suggested Resolution** |
| 112 | 2328.40 | Interaction between HWMP element transaction and forwarding information is a little vague. In typical implementaion, forwarding information is created in control/management plane (MLME) and will be passed to data plane (MAC) once the information is validated. However, there is no mentioning of such interaction in the current specification. Due to lack of proper interaction between MLME (write section) and MAC (read section), HWMP reference implementation in Linux kernel is not working well. The specification should have clear description. | Suggest to add how the forwarding information is handled between MLME and MAC. Commenter is willing to provide resolutin text. | REVISED: Adopt changes proposed in doc11-17/1529r1. |

# Discussion:

Forwarding information is used to enable MSDU/MMPDU forwarding in MAC. It is used as look-up-table to determine next-hop STA toward the destination STA. The forwarding information is created as a result of the path selection protocol message exchange. Hence, MLME creates the forwarding information.

Intended behaviour here is:

* MLME uses forwarding information memory space as working space. Once end-to-end path is validated, MLME transfers the forwarding information to MAC
* MAC uses validated forward information as look-up-table.

However, current standard does not have clear description when forwarding information is validated so MAC can use it for MSDU/MMPDU forwarding.



Forwarding information

So, when the forwarding information shall be validated?

The standard defines the default path selection protocol, HWMP. HWMP uses four different type of frames to determine end-to-end path, i.e., RANN, PREQ, PREP, and PERR.

Although there are some variation to generate an end-to-end path, the validation of the end-to-end path shall be made at the timing when PREP is transmitted or PREP is received. Note that PREP is used to confirm the end-to-end path.

# Summary of the suggested change:

1. Make clear that MAC only refers to validated forwarding information for MSDU/MMPDU forwarding
2. Add sentence when the forwarding information is validated, i.e., at the time when PREP is processed
3. Clean up text to make it more reader friendly

# Feedback received at a conference call:

1. Describe what MAC would do when the forwarding information is invalid explicitly. (Adrian)
2. It could be a good idea if we can add validate action to the table in the doc. (Mark)

# Work have been done after that:

1. Added a paragraph describing what STA shall/may do when the forwarding information is invalid.
2. Added a table summarizing when the forwarding information shall be validated and invalidated.

# Proposed changes:

Apply the following changes.

Corresponding changes to D0.3 are indicated in the following text with “Track Changes” on, to clarify the direction to the editor. Please update the part indicated by the “Track Changes” only.

***To REVmd Editor: Change the subclause 10.37.2 as follows:***

* Mesh forwarding framework
* Forwarding information

Forwarding information is created by the active mesh path selection protocol and is utilized for MSDU/MMPDU forwarding as described in 10.37.3 (Addressing and forwarding of individually addressed mesh Data frames) and 10.37.5.2 (MMPDU forwarding using individually addressed Multihop Action frames).

The basic forwarding information to a destination mesh STA consists of the destination mesh STA address, the next-hop address, the precursor list, and the lifetime of this forwarding information.

An entry in the precursor list contains the precursor mesh STA address and the lifetime of this entry. If an existing entry in a precursor list is updated, the lifetime is the maximum of the current and the updated value. If the lifetime of a precursor expires, it will be deleted from the precursor list. Precursors are used to identify legitimate transmitters of individually addressed frames (see 10.37.3.2 (At intermediate and destination mesh STAs (individually addressed))) and for the notification of link failures (in case of HWMP, see 14.10.11 (Path error (PERR) mechanism)).

The forwarding information shall be considered as valid when the active mesh path selection protocol validates it. When STA performs MSDU/MMPDU forwarding, it shall use valid forwarding information only.

If STA finds its forwarding information to a particular destination mesh STA is not validated, it shall consider the corresponding next-hop address is unknown and may take necessary action to forward MSDU/MMPDU appropriately. See 10.37.8 (MSDU forwarding and unknown destination) and 14.10.9.3 (Conditions for generating and sending a PREQ element) for HWMP case.

The forwarding information shall be considered as invalid if its lifetime has expired. Also, forwarding information is marked as invalid when certain conditions are met in the processing of mesh path selection elements, e.g., path error processing in HWMP (14.10.11.4 (PERR element processing)).

The active path selection protocol may define additional parameters in the forwarding information. Details on the additional parameters of the forwarding information constructed by the hybrid wireless mesh protocol (HWMP) are described in 14.10.8.4 (Forwarding information).

***To REVmd Editor: Change the subclause 10.37.8 as follows:***

* MSDU forwarding and unknown destination

A source mesh STA in the MBSS might not able to forward an MSDU that it has received as a consequence of an MA-UNITDATA.request primitive with an individual destination address. This is the case if the destination of the MSDU is unknown to the mesh STA. The destination is unknown to a mesh STA if the mesh STA has no valid forwarding information for this destination or if the destination is not in its proxy information as an external STA (see 14.11.4.2 (Proxy information)). Note that the procedure to determine that an address is unknown depends on the active path selection protocol. It might require an attempt to establish a path to the destination (see 14.8 (Mesh path selection and metric framework)).

If the source mesh STA is not able to forward the MSDU because its destination is unknown, the mesh STA shall assume that the destination is outside the MBSS and shall forward the MSDU to known mesh gates in the MBSS as one or more individually addressed frames according to the procedures for frame addressing and data forwarding of individually addressed frames at source mesh STAs in an MBSS (10.37.3.1 (At source mesh STAs (individually addressed))). These frame(s) shall be transmitted using the four-address MAC header format (with the Address Extension Mode subfield in the Mesh Control field set to “Address5&6” (see Table 9-24 (Valid values for the Address Extension Mode subfield))), where the Mesh Address Extension subfield in the Mesh Control field carries the address of the destination end station, as specified in row “Mesh Data (proxied, individually addressed)” of Table 9-47 (Valid address field usage for Mesh Data and Multihop Action frames). The address fields are set as follows:

* Address 1: The address of the next-hop mesh STA (toward the known mesh gate in the MBSS according to the forwarding information—see 10.37.2 (Forwarding information)).
* Address 2: The address of the source mesh STA.
* Address 3: The address of the known mesh STA in the MBSS.
* Address 4: The address of the source mesh STA.
* Address 5: The address of the destination end mesh STA, which is the unknown destination address of the MSDU
* Address 6: The address of the source mesh STA, which is the same as Address 4

If there is no mesh gate available, the mesh STA shall silently discard the MSDU.

Discovery of mesh gates by mesh STAs is performed using propagated elements, such as a GANN (14.11.2 (Gate announcement (GANN))). Other methods specific to the HWMP path selection protocol are also available, such as the proactive PREQ mechanism (14.10.4.2 (Proactive PREQ mechanism)) or the proactive RANN mechanism (14.10.4.3 (Proactive RANN mechanism)), when the Gate Announcement subfield in the Flags field in these HWMP elements is set to 1.

***To REVmd Editor: Change the subclauses under 14.10.8.4 as follows:***

* Hybrid wireless mesh protocol (HWMP)
* Forwarding information

In addition to the parameters contained in the basic forwarding information as described in 10.37.2 (Forwarding information), the forwarding information to a destination defined by HWMP also contains at least the destination HWMP SN, the path metric, and the number of hops.

Upon PREQ element and PREP element processing, mesh STA shall create or update the forwarding information as follows:

* The mesh STA may create or update its forwarding information to the transmitter of the element if the path metric improves.
* The mesh STA shall create or update its forwarding information to the originator mesh STA, if it received a PREQ element, and one of the following conditions is met:
* The originator HWMP SN > HWMP SN in the forwarding information for this originator mesh STA, or
* The originator HWMP SN = HWMP SN in the forwarding information for this originator mesh STA AND the updated path metric is better than the path metric in the forwarding information.
* The mesh STA shall create or update its forwarding information to the target mesh STA, if it received a PREP element, and one of the following conditions is met:
* The Target HWMP SN > HWMP SN in the forwarding information for this target mesh STA, or
* The Target HWMP SN = HWMP SN in the forwarding information for this target mesh STA AND the updated path metric is better than the path metric in the forwarding information.

Table 14-9 (Data for creation and update of forwarding information due to PREQ element and PREP element) defines the values to be stored in the different fields of the forwarding information after a PREQ element or PREP element has been received. Details of PREQ element processing and PREP element processing are described in 14.10.9 (Path request (PREQ) mechanism) and 14.10.10 (Path reply (PREP) mechanism) respectively.

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| --- |
| * Data for creation and update of forwarding information due to PREQ element and PREP element
 |
| Field of forwarding information | Received PREQ element | Received PREP element |
| Forwarding information for transmitter of PREQ element | Forwarding information for originator mesh STA | Forwarding information for transmitter of PREP element | Forwarding information for target mesh STA |
| HWMP SN | Invalid if created, no change if updated | PREQ element field Originator HWMP Sequence Number | Invalid if created, no change if updated | PREP element field Target HWMP Sequence Number |
| Next hop | Transmitter address of the Management frame containing the PREQ element | Transmitter address of the Management frame containing the PREQ element | Transmitter address of the Management frame containing the PREP element | Transmitter address of the Management frame containing the PREP element |
| Path metric | Accumulation of the initial value of the path metric with the metric of the link to the transmitter of the PREQ element | Accumulation of the value of PREQ element field Metric with the metric of the link to the transmitter of the PREQ element | Accumulation of the initial value of the path metric with the metric of the link to the transmitter of the PREP element | Accumulation of the value of PREP element field Metric with the metric of the link to the transmitter of the PREP element |
| Number of hops | 1 | Value of PREQ element field Hop Count + 1 | 1 | Value of PREP element field Hop Count + 1 |
| Precursor list | No change | No change except in case of an intermediate reply [see 14.10.9.4.3 (Effect of receipt) step f)] | No change | See 14.10.10.4.3 (Effect of receipt) step d) |
| Lifetime | The longer one of the lifetime of the stored forwarding information and the value of PREQ element field Lifetime | The longer one of the lifetime of the stored forwarding information and the value of PREQ element field Lifetime | The longer one of the lifetime of the stored forwarding information and the value of PREP element field Lifetime | The longer one of the lifetime of the stored forwarding information and the value of PREP element field Lifetime |

Upon PREP element processing, mesh STA shall validate the forwarding information as follows:

* When mesh STA transmits a PREP element, it shall validate its forwarding information to the originator mesh STA of the PREP element.
* When mesh STA receives a PREP element, it shall validate its forwarding information to the target mesh STA of the PREP element.

If mesh STA is unable to forward an MSDU/MMPDU to a next-hop STA as indicated in the forwarding information, it shall invalidate the corresponding forwarding information (See 14.10.11.3 (Conditions for generating and sending a PERR element)). When mesh STA receives PERR element, it shall invalidate the forwarding information to the unreachable destination mesh STA indicated in the PERR element. The forwarding information shall be invalidated if its lifetime has expired.

Table 14-10 (Validation and invalidation of the forwarding information) summarizes timing to validate or invalidate the forwarding information.

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| Table 14—10 --- Validation and invalidation of the forwarding information  |
| Event | Action |
| Transmitted PREP element | Validate forwarding information to the originator mesh STA of the PREP element |
| Received PREP element | Validate forwarding information to the target mesh STA of the PREP element |
| Unable to forward MSDU/MMPDU to a next-hop STA | Invalidate forwarding information that uses the next-hop STA |
| Received PERR element | Invalidate forwarding information to the unreachable destination STA indicated in the Destination Address field in the PERR element |
| Forwarding information lifetime expiration | Invalidate forwarding information that the lifetime is expired |

Details of PREP element processing and PERR element processing are described in 14.10.10 (Path reply (PREP) mechanism) and 14.10.11 (Path error (PERR) mechanism) respectively.

***To REVmd Editor: Add the following paragraph to the end of subclause 14.10.10.3:***

* Path reply (PREP) mechanism
* Conditions for generating and sending a PREP element

When a mesh STA sends out a PREP element in an HWMP Mesh Path Selection frame, it shall validate the forwarding information to the originator mesh STA indicated in the PREP element.

***To REVmd Editor: Change the subclause 14.10.10.4.3 as follows:***

* PREP element processing
* Effect of receipt

A mesh STA receiving a PREP element according to the acceptance criteria in 14.10.10.4.2 (Acceptance criteria) shall create or update the forwarding information it maintains for the target mesh STA of the PREP element (according to the rules defined in 14.10.8.4 (Forwarding information)). Further, the mesh STA shall validate the forwarding information to the target mesh STA indicated in the PREP element. If the conditions for creating or updating the forwarding information have not been met in those rules, no further steps are applied to the PREP element.

If the active forwarding information was created or updated according to the rules defined in 14.10.8.4 (Forwarding information), the following apply:

* If the receiving mesh STA is not the final destination of the PREP element (originator mesh STA) and the field Element TTL > 1, the PREP element is propagated as defined in 14.10.10.3 (Conditions for generating and sending a PREP element) Case B.
* If the receiving mesh STA is the final destination of the PREP element (originator mesh STA) and its AE subfield in the Flags field is 1, the mesh STA shall store the Target External Address, the Target Mesh STA Address, and the HWMP Sequence Number as proxy information sequence number in its proxy information. The proxy lifetime is the longer one of the value of the PREP element Lifetime field and the proxy lifetime if the proxy information already exists (see also 14.11.4.3 (Proxy update (PXU))).
* If the receiving mesh STA is not the final destination of the PREP element (originator mesh STA) and its AE subfield in the Flags field is 1, the mesh STA may store the Target External Address, the Target Mesh STA Address, and the HWMP Sequence Number as proxy information sequence number in its proxy information. The proxy lifetime is the longer one of the value of the PREP element Lifetime field and the proxy lifetime if the proxy information already exists (see also 14.11.4.3 (Proxy update (PXU))).
* If the mesh STA propagates the PREP element, the precursor list for the Target Mesh STA Address is updated by adding the next-hop mesh STA to which the PREP element is propagated. In addition, at the mesh STA the precursor list for the originator mesh STA address is updated by adding the next-hop mesh STA toward the Target Address. The lifetimes of these entries in the precursor lists are the values of the lifetimes of the corresponding forwarding information.

# Reference:

[1] Draft P802.11REVmd\_D0.3.

[2] 11-17/927 “REVmd Working Group Comments for MAC ad-hoc”