IEEE P802.11
Wireless LANs

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| CC36 comment resolution: Multi-Link Fragmentation |
| Date: 2020-08-20 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
| Liwen Chu | NXP |  |  | Liwen.chu@nxp.com |

Abstract

This submission proposes resolutions for multiple comments related to TGbe D1.0 with the following CIDs:

 5063, 4015

Revisions:

* Rev 0: Initial version of the document.

Interpretation of a Motion to Adopt

A motion to approve this submission means that the editing instructions and any changed or added material are actioned in the TGbe Draft. This introduction is not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGbe Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

***TGbe Editor: Editing instructions preceded by “TGbe Editor” are instructions to the TGbe editor to modify existing material in the TGbe draft. As a result of adopting the changes, the TGbe editor will execute the instructions rather than copy them to the TGbe Draft.***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **PP** | **LL** | **Comment** | **Proposed Change** | Resolution |
| 5063 | 133 | 32 | When a Per-STA Profile subelement of the Basic variant Multi-Link element carries the complete profile of a reported STA of an MLD, even with inheritance, there may be scenarios where the size of the subelement exceeds 255 octets. It is not clear how the spec addressed this scenario. | As in comment. The commenter will provide a contribution to address this issue. | **Revised**Agree with the commenter. A procedure to fragment the Per-STA Profile subelement when the size of the subelement content exceeds 255 octets is defined. MLProbe Request/Response Action frames are defined to avoid the fragmentation of ML element and Per-STA Profile as subelement in Multiple BSSID element. This can avoid the implementation complexity.**TGbe editor, please incorporate changes as shown in 11-21/1508r3 tagged 5063** |
| 4015 | 133 | 27 | Table 9-92 indicates if an element is fragmentable or not. Clause 10.28.11 defines the procedure if the Information field of a fragmentable element is more than 255 octets. However, there is no procedure defined for the case where the Data field of a subelement (within an element) is more than 255 octets. It is possible that the Per-STA Profile subelement of the Basic variant Multi-Link element is greater than 255 octets. | Define a procedure to handle the case where the Per-STA Profile subelement carries in the Link Info field of Multi-Link element is greater than 255 octets. | **Revised**Agree with the commenter. A procedure to fragment the Per-STA Profile subelement when the size of the subelement content exceeds 255 octets is defined. MLProbe Request/Response Action frames are defined to avoid the fragmentation of ML element and Per-STA Profile as subelement in Multiple BSSID element. This can avoid the implementation complexity.**TGbe editor, please incorporate changes as shown in 11-21/1508r3 tagged 5063** |

Discussion:

This submission proposes spec text for subelement fragmentation based on Part B of [11-21/1175r4](https://mentor.ieee.org/802.11/dcn/21/11-21-1175-04-00be-cc36-resolution-for-cids-related-to-ml-advertisement-part-1.docx) (Abhishek Patil) with additional changes to simplify the MLO design for handling the case where an AP corresponding to nontransmitted BSSID is affiliated with an AP MLD.

Subelement fragmentation (from 11-21/1175)

Each Per-STA Profile carries information specific to a STA affiliated with an MLD. For example, during MLO discovery and ML (re)setup, the Per-STA Profile subelement for each reported STA carries complete profile. When the profile carries complete information, the inheritance mechanism would help keep the profile size small. However, in scenarios where the reported STA has many fields/elements that are different from the reporting STA or specific to the reported STA, it is possible that the subelement size exceeds 255 octets. The Multi-Link element is fragmentable and the procedures described in clauses 10.28.11 and 10.28.12 would apply. However, there is no procedure defined for handling the case where a subelement size exceeds 255 octets. For example, the length field in the subelement can only signal up to 255 octets. The MLO framework needs to define a procedure for fragmenting a subelement when the content of the subelement exceed 255 octets. This issue is not seen in case of Nontransmitted BSSID Profile subelement carried in a Multiple BSSID element because the baseline standard requires carrying multiple Multiple BSSID elements with the nontransmitted BSSID profile fragmented across multiple Nontransmitted BSSID Profile subelements that are carried across different Multiple BSSID element. Also note, Multiple BSSID element is a legacy element and can’t be fragmented – i.e., Fragment element (defined by 11ai) does not apply to Multiple BSSID element.

This contribution defines a subelement fragmentation procedure for Per-STA Profile subelement of Multi-Link element that is similar to the element fragmentation procedure described in 10.28.11.

Eliminating the need for multi-level fragmentation:

When a non-AP MLD performs ML probing to gather complete information of other APs affiliated with an AP MLD that is affiliated with an AP corresponding to the nontransmitted BSSID on the link, the (ML) Probe Response frame, sent by the AP corresponding to the transmitted BSSID carries multiple Multiple BSSID elements containing Nontransmitted BSSID Profile subelements (that are fragmented across the multiple elements) which include the Basic Multi-Link element which is fragmented due to the large size of Per-STA Profile subelement of the affiliated APs.

Such a design consisting of multi-element multi-level fragmentation as shown in the figure below is very complicated, error prone, difficult to implement and would lead to inter-op issues. In addition, there is also a conflict regarding the value carried in the Length field of the fragmented Multi-Link element (and its corresponding Fragment element(s)).



The issue of multi-element multi-level fragmentation occurs only for the case of Probe Response frame during ML probing where the AP MLD is affiliated with an AP corresponding to the nontransmitted BSSID. The issue doesn’t exist in case of ML setup since the (Re)Association Response frame is sent directly by the intended AP (i.e., the one corresponding to the nonTxBSSID).

To simplify the overall design and address the issue of multi-level fragmentation, this document proposes to use a different frame type for performing ML probing. The proposal defined Action frames for ML Probe Request and ML Probe Response. With this change, ML probing involving nonTxBSSID is not bound by the baseline rules for sending a Probe Response frame. In other words, the AP corresponding to the nonTxBSSID can directly respond to the ML Probe Request frame and carry the Multi-Link element (fragmented or otherwise) directly in the core frame.

As a side benefit of this change, the spec text at several locations is simplified to make direct reference to Probe Response frame or an ML Probe Response frame. TGbe can get rid of references such as ‘a Probe Response frame that is *[not]* an ML probe response frame’ and so on.

End of the discussion

**9.4.2.312 Multi-Link element**

**9.4.2.312.1 General**

***TGbe editor: Please update Table 9-401c as shown below:***

**Table 9-401c—Optional subelement IDs for Multi-Link element(#5833)**

|  |  |  |
| --- | --- | --- |
| **Subelement ID** | **Name** | **Extensible** |
| 0 | Per-STA Profile | Yes |
| 1–220 | Reserved |  |
| 221 | Vendor Specific | Vendor defined |
| 222 – 253 | Reserved |  |
| 254 | Fragment | No |
| 255 | Reserved |  |

***TGbe editor: Please add the following as a new subclause after subclause 35.3.2.3:***

**35.3.2.4 Per-STA Profile Subelement Fragmentation**[5063]

If the length of a Per-STA Profile subelement for a reported STA exceeds 255 octets, the transmitting STA shall fragment the contents across a series of subelements consisting of the Per-STA Profile subelement (Subelement ID set to 0), immediately followed by one or more Fragment subelements (Subelement ID set to 254) as illustrated in Figure 35.xx (Per-STA Profile subelement fragmentation). All the information for a fragmented subelement shall be carried across the same Basic variant Multi-Link element and its Fragment element(s). A Per-STA profile subelement shall not be fragmented if the length of the Data field of the subelement is less than 255 octets. A Fragment subelement shall not be the first subelement or the only subelement within a Link Info field of the Basic variant Multi-Link element.

NOTE – When the Per-STA Profile subelement length is greater than 255 octets, the length of Basic variant Multi-Link element that carries the subelement would exceed 255 octets. As a result, the element will be fragmented by following the procedure defined in 10.28.11 (Element fragmentation).



**Figure 35-xx: Per-STA Profile subelement fragmentation**

The information to be fragmented is divided into *P* + *Q* portions, where the following define each variable:

* *L* is the size of the information in octets.
* *P* is .
* *Q* is equal to 1 if *L* mod 255 > 0 and equal to 0 otherwise.

The Per-STA Profile subelement into which the information does not fit is filled with the first segment of information. This subelement is immediately followed by *P* – 1 Fragment subelements, each containing the subsequent segments of 255 octets of information. If *Q = 1*, these subelements are immediately followed by another Fragment subelement containing the remaining segment of information. The length of this last Fragment subelement shall be (L mod 255).

NOTE—A Fragment subelement never follows a subelement with fewer than 255 octets of information.

A Per-STA Profile subelement that has its information fragmented shall be followed by one or more Fragment subelements. To reconstruct the original information, the portion of information from the Per-STA Profile subelement shall be concatenated, in order, with the portions of information from the series of Fragment subelements that follow it. The defragmentation procedure shall complete when any subelement other than a Fragment subelement is encountered or the end of the last Fragment element of the Basic variant Multi-Link element is reached.

NOTE – The receiving STA follows the procedure defined in 10.28.12 (Element defragmentation) to defragment the Basic variant Multi-Link element.

* + - 1. **Probe Request frame format**

***TGbe editor: change 9.3.3.5 as follows(#5063)***

**Table 9-38—Probe Request frame body(#1004)(#2246)(#3357)**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
|  |  |  |
| <Last assigned + 1> | EHT Capabilities | The EHT Capabilities element is present if dot11EHTOptionIm- plemented is true; otherwise it is not present. |

**9.4.2.295b.3 Probe Request variant Multi-Link element**

***TGbe editor: change the first paragraph in 9.4.2.295b.3 as follows: (#5063)***

The Probe Request variant Multi-Link element is used to request an AP to provide information of other APs affiliated with the same AP MLD as the AP.(#2583)(#3360).

**9.6.7 Public Action details**

**9.6.7.1 Public Action frames**

***TGbe editor: add the following two rows in Table 9-408 (Public Action field values) of 9.6.7.1: (#5063)***

|  |  |
| --- | --- |
| <ANA> | MLProbe Request |
| <ANA> | MLProbe Response |

***TGbe editor: add the following subclauses in 9.6.7 as follows: (#5063)***

**9.6.7.x1 MLProbe Request frame format**

A STA affiliated to an non-AP MLD uses the MLProbe Request frame to solicit MLProbe Response from an AP affiliated with an AP MLD. The Action field of the MLProbe Request frame contains the information shown in Table 9-xxx1 (MLProbe Request frame Action field format).

**Table 9-xxx1 MLProbe Request frame Action field values**

|  |  |
| --- | --- |
| **Value** | **Meaning** |
| 1 | Category |
| 2 | Public Action |
| 3 | Request |
| 4 | Extended Request |
| 5 | Multi-Link |
| 6 | Vendor Specific |

**9.6.7.x2 MLProbe Response frame format**

An AP affiliated with an AP MLD responds with the MLProbe Response after receiving a MLProbe Request. The Action field of the MLProbe Response frame contains the Category, Public Action, the IEs of the reported link requested in soliciting MLProbe Request (if any), and basic variant Multi-Link element.

**9.6.10 Protected Dual of Public Action frames**

***TGbe editor: add the following two rows in Table 9-448 (Public Action field values defined for Protected Dualof Public Action frames) of 9.6.10: (#5063)***

|  |  |  |
| --- | --- | --- |
| <ANA> | Protected MLProbe Request | 9.6.7.x1 (MLProbe Request frame format)  |
| <ANA> | Protected MLProbe Response | 9.6.7.x2 (MLProbe Response frame format) |

**35.3.2 Advertisement of multi-link information in Multi-Link element(#2294)**

**35.3.2.1 General**

***TGbe editor: change the 1st, 2nd paragraphes in 35.3.2.1 as follows: (#5063)***

(#2241)(#1154)(#2850)(#2450)(#3366)(#3152)(#1716)(#2898)(#1155)(#1414)(#2581)(#3367)(#3359)(#2859)(#2295)An AP affiliated with an AP MLD shall follow the rules defined in 35.3.4.4 (Multi-Link element usage rules in the context of discovery) for including a (#6700)Basic Multi-Link element in a Beacon frame that it transmits or in a Probe Response frame that it transmits.

(#1155)(#1414)(#2581)(#3367)(#3359)(#2859)(#2295)An AP affiliated with an AP MLD shall follow the rules in 35.3.4.2 (Use of MLProbe Request and Response(#2583)(#3360)) for including a (#6700)Basic Multi-Link element in a MLProbe Response frame that it transmits.

***TGbe editor: change the 4th paragraph in 35.3.2.1 as follows: (#5063)***

(#1183)(#1777)(#1918)(#2414)(#2582)(#3211)(#3249)(#3368)(#2182)(#2295)A STA affiliated with a non-AP MLD shall follow the rules in 35.3.4.2 (Use of MLProbe Request and Response(#2583)(#3360)) for including a (#6701)Probe Request Multi-Link element in a MLProbe Request frame that it transmits.

**35.3.2.2 Advertisement of complete or partial per-link information(#1859)**

***TGbe editor: change 35.3.2.2 as follows (the paragraphes not shown are not changed): (#4018)***

……

(#8329)NOTE 1—Only Management frames belonging to subtypes (Re)Association Request, (Re)Association Response, or MLProbe Response can carry complete profile of a reported STA.

……

(#4035)(#1034)(#2149)(#1861)(#2831)An AP affiliated with an AP MLD shall not include a complete profile of a reported AP affiliated with the same AP MLD in the Beacon frame or a Probe Response frame that it transmits.

(#4035)NOTE 3—See 35.3.10 (Multi-link procedures for channel switching, extended channel switching, and channel quieting(#4112)(#2324)(#2600)) for conditions when a Beacon or a Probe Response frame transmitted by an AP affiliated with an AP MLD carries a partial profile of reported AP(s).

(#1034)(#1833)(#2149)(#1861)(#2831)An AP affiliated with an AP MLD may include either the complete profile or the partial profile of a reported AP affiliated with the same AP MLD in a MLProbe Response frame that it transmits, as defined in 35.3.4.2 (Use of MLProbe Request and Response(#2583)(#3360)).

……

(#4248)(#6396)(#6570)(#7514)(#1860)Each Per-STA Profile subelement of the Basic Multi-Link element that is included in a Management frame transmitted by a STA affiliated with an MLD and that carries a complete profile shall consist of the STA Control field to identify the link on which the reported STA operates on and to carry the presence indicators for the subfield(s) within the STA Info field, the STA Info field, and the STA Profile field containing fields and elements based on the following rules:

* (#1036)(#1864)(#2451)(#2964)(#2586)(#1184)If the reporting STA is an AP, the STA Profile field corresponding to the reported AP:
	+ carries fields and elements in the same order and subject to the conditions as in:
		- Table 9-67 (Probe Response frame body(#1004)(#2246)(#3359)) if the frame is an MLProbe Response.

……

**35.3.2.3.2 Inheritance in the per-STA profile of Probe Request Multi-Link ele-ment(#2416)(#6700)**

***TGbe editor: change 35.3.2.3.2 as follows(the paragraphes not shown are not changed): (#5063)***

(#5737)If a non-AP STA affiliated with a non-AP MLD requests the same partial profile for an AP to which it sends an MLProbe Request and for another AP affiliated with the same AP MLD as the AP and that is requested in the MLProbe Request (see 35.3.4.2 (Use of MLProbe Request and Response(#2583)(#3360))), the non-AP STA may include the (Extended) Request element only in the MLProbe Request frame body, and this element will be inherited for the other requested AP even if it is not carried in the Per-STA Profile subelement corresponding to the other requested AP, following the rules defined in 35.3.4.2 (Use of MLProbe Request and Response(#2583)(#3360)).

Figure 35-5 (Example of inheritance in a Request element for MLProbe request(#6701)(#2416)) illustrates a MLProbe request transmitted by a non-AP STA that is affiliated with a non-AP MLD. (#5737)The non-AP STA requests partial profile for three APs and complete profile for one AP, where all APs are affiliated with the same AP MLD. The non-AP STA includes a Request element in the MLProbe Request frame body requesting the element with element ID “a” for the AP to which the MLProbe Request frame is sent. The frame carries a (#6701)Probe Request Multi-Link element that includes three Per-STA Profile subelements requesting information for AP x, AP y, AP z.

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## Figure 35-5—Example of inheritance in a Request element for MLProbe Request (#6701)(#2416)

***TGbe editor: change 35.3.4.2 as follows:(#5063)***

35.3.4.2 Use of MLProbe Request and Response(#2583)(#3360)

(#2583)(#3360)(#1187)An MLProbe Request is used to discover an AP:

* + - * + (#1045)(#1187)(#1673)(#2150)with the Address 1 field set to the broadcast address and the Address 3 field set to the BSSID of an AP, or with the Address 1 field set to the BSSID of an AP’s BSS.
				+ (#6262)(#6237)(#6238)with the MLD ID subfield (if present) set to the MLD ID that identifies the targeted AP MLD with which the requested AP(s) are affiliated.
				+ (#1808)(#2124)(#3217)and that includes a (#6701)Probe Request Multi-Link element defined in 9.4.2.312.3 (Probe Request Multi-Link element(#6701)).

(#6262)(#6237)(#6238)If either the Address 1 field or the Address 3 field of the MLProbe Request is set to the MAC address of the AP affiliated with an AP MLD that corresponds to the nontransmitted BSSID, then the MLD ID subfield shall not be present in the Probe Request Multi-Link element of the MLProbeRequest and the AP MLD is the targeted AP MLD.

(#6262)(#6237)(#6238)If either the Address 1 field or the Address 3 field of the MLProbe Request is set to the MAC address of the responding AP that operates on the same link where the MLProbe Request is sent, then the MLD ID subfield shall be present in the Probe Request Multi-Link element of the MLProbe Request and the targeted AP MLD is identified by the MLD ID subfield.

(#1046)(#2151)(#2583)(#3360)(#1675)An MLProbe Request allows a non-AP STA to request an AP to include the complete or partial set of capabilities, parameters and operation elements of (#6262)(#6237)(#6238)the AP(s) affiliated with the targeted AP MLD in the response frame. An AP affiliated with the targeted AP MLD is a requested AP if one of the following conditions is met:

* + - * + the Probe Request Multi-Link element in the MLProbe Request frame does not include any per-STA profile.
				+ (#1420)the link ID of the AP is equal to the value in the Link ID field in a Per-STA Profile subelement in the Probe Request Multi-Link element in the MLProbe Request frame.

(#5737)(#1744)(#1047)The complete profile of a requested AP is defined in [35.3.2.2 (Advertisement of](#bookmark8) [complete or partial per-link information(#1859))](#bookmark8).

(#5737)(#2416)The partial profile of a requested AP sent by a reporting AP consists of one or more elements that are requested in the (Extended) Request element carried in the MLProbe Request.

(#5737)(#2416)If a STA affiliated with a non-AP MLD sends an MLProbe Request to an AP to retrieve partial profile for AP(s) affiliated with the (#6262)(#6237)(#6238)targeted AP MLD, the STA shall include the (Extended) Request element in the MLProbe Request frame body and/or a Per-STA Profile subelement in a (#6701)Probe Request Multi-Link element carried in the MLProbe Request frame. In this case, the Complete Profile subfield of the STA Control field in the Per-STA Profile subelement shall be set to 0. (#5737)The (Extended) Request element carried in the per-STA profile corresponding to the requested AP that requests the same partial profile as the AP can be inherited from the (Extended) Request element in the frame body, subject to the rules defined in [35.3.2.3.2 (Inheritance in the per-STA profile of Probe Request Multi-Link](#bookmark13) [element(#2416)(#6700))](#bookmark13).

(#5737)(#2416)An MLProbe Request allows a non-AP STA to request an AP to include the complete profile of all APs affiliated with the (#6262)(#6237)(#6238)targeted AP MLD if the MLProbe Request frame does not include the (Extended) Request element in the frame body and the (#6701)Probe Request Multi-Link element in the MLProbe Request frame does not include any per-STA profile.

(#5737)(#2416)An MLProbe Request allows a non-AP STA to request an AP to include the same requested partial profile for all APs affiliated with the (#6262)(#6237)(#6238)targeted AP MLD if the MLProbe Request frame includes the (Extended) Request element in frame body and the (#6701)Probe Request Multi-Link element in the MLProbe Request frame does not include any per-STA profile.

(#1155)(#1414)(#2581)(#3367)(#3359)(#2859)An MLProbe Response is a Action frame:

* + - * + that is transmitted in response to receiving an MLProbe Request
				+ and that is transmitted by an AP affiliated with the AP MLD identified by the soliciting MLProbe Request frame
				+ and that includes (#6700)Basic Multi-Link element which can carry complete or partial per-STA profile(s), based on the soliciting request, for each of the requested AP(s) of the (#6262)(#6237)(#6238)targeted AP MLD.

If the MLProbe Request frame is soliciting information of an AP MLD that is affiliated with an AP corresponding to the nontransmitted BSSID in a multiple BSSID set, then the AP corresponding to the nontransmitted BSSID shall respond with an MLProbe Response frame. The TA field of such an MLProbe Response frame shall be set to the nontransmitted BSSID and the frame does not carry Multiple BSSID element.

(#5737)(#2416)(#2583)(#3360)(#1422)If an AP that is affiliated with an AP MLD receives an MLProbe Request from a non-AP STA requesting complete profile, it shall respond with an MLProbe response that includes a (#6700)Basic Multi-Link element with (#2419)a per-STA profile with complete profile for each of the APs that are affiliated (#6262)(#6237)(#6238)with the targeted AP MLD and that are requested by the MLProbe Request(#1048). (#5737)If it receives an MLProbe Request from a non-AP STA requesting partial profile, it shall respond with an MLProbe Response that includes a (#6700)Basic Multi-Link element with (#2419)a per-STA profile with at least the elements requested from the (Extended) Request element for each of the APs that are affiliated (#6262)(#6237)(#6238)with the targeted AP MLD and that are requested by the MLProbe Request, unless the elements requested are not part of the complete profile for each of the APs (#1048).

(#5737)(#2583)(#3360)(#1423)If an AP that is operating in the 2.4 GHz band or the 5 GHz band that is part of an AP MLD receives an MLProbe Request requesting complete profile and responds with an MLProbe Response , the Address 1 field of the MLProbe Response frame may be set to the broadcast address unless the AP is not including its actual SSID in the SSID element of its Beacon frames.

(#5737)(#1676)(#1042)(#1044)None of the non-AP STAs of a non-AP MLD shall send an MLProbe Request to an AP of the AP MLD in the corresponding link if any non-AP STA of the same non-AP MLD has already received a MLProbe Response including complete profile from any of the AP of the AP MLD in any link, since the MLME-SCAN.request primitive with ScanType parameter indicating an active scan was issued.

35.3.4.3 Non-AP behavior(#1010)(#1020)

***TGbe editor: change 35.3.4.3 as follows(the paragraphes not shown are not changed): (#5063)***

A non-AP MLD shall be able to discover an AP MLD when it receives a (#6700)Basic Multi-Link element carried in a Beacon frame or Probe Response frame transmitted by an AP affiliated with the AP MLD or by the AP corresponding to the transmitted BSSID in the same multiple BSSID set as at least one of the APs affiliated with the AP MLD.

A non-AP MLD shall be able to discover an AP MLD and the capabilities and operational parameters of one or more APs affiliated with an AP MLD when it receives a (#6700)Basic Multi-Link element that carries a complete profile of the reported AP carried in the MLProbe Response frame transmitted by an AP affiliated with the AP MLD.

……

35.3.4.4 **Multi-Link element usage rules in the context of discovery**

***TGbe editor: change the first paragraph in 35.3.4.4 as follows: (#5063)***

(#3016)(#1005)(#1896)(#1155)(#1414)(#2581)(#3367)(#3359)(#2859)(#2241)(#2295)An AP affiliated

with an AP MLD shall include, in a Beacon frame or a Probe Response frame only the Common Info field of the (#6700)Basic Multi-Link element as defined in 9.4.2.312 (Multi-Link element) unless conditions in [35.3.10 (Multi-link procedures for channel switching, extended](#bookmark32) [channel switching, and channel quieting(#4112)(#2324)(#2600))](#bookmark32) are satisfied.

***TGbe editor: change the 3rd, 4th paragraphes in 35.3.4.4 as follows: (#5063)***

(#2583)(#3360)A Probe Request frame shall not include a Multi-Link element of any type.

(#1192)(#2581)(#3367)(#6700)A MLProbe Request frame shall include a Probe Request Multi-Link element and shall not include other variant Multi-Link element.