IEEE P802.11
Wireless LANs

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| A-MSDU Fragmentation |
| Date: 2016-11-05 |
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Abstract

This submission proposes the addition of a capability bit to signal support for receipt of fragmented A-MSDUs.

**REVISION NOTES:**

**R0: initial**

**R1:**

Added changes to 25.3 – i.e. added A-MSDU to HE Fragmentation subclause

**R2:**

Removed most changes to 10. 5 Fragmentation and 10.6 Defragmentation – the current philosophy is to have all new material within a new subclause, which in this case is 25.3 dynamic fragmentation – the changes to 10.5 and 10.6 included a few normative statements regarding when A-MSDU fragmentation could be used, based on the setting of the A-MSDU Fragmentation support bit – these statements were moved to 25.3 – the other changes in 10.5 and 10.6 were to include A-MSDU in the descriptions of which items could be fragmented, and those are simply removed – one item of interest remains in 10.5, which is a reference change for the maximum sizes

**R3:**

Fixed MIB variable – it had the wrong name

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 TGax Draft. This introduction is not part of the adopted material.

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

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

**Discussion:**

* **Various levels of dynamic fragmentation defined**
	+ **Intended to allow implementation choice of tradeoff**
		- **Complexity/cost**
		- **Performance**
* **Dynamic Fragmentation Support level is advertised**
	+ **To allow full interoperability at the highest common level**
* **AMSDU is currently NOT allowed to be fragmented**
	+ **See later slides for details**
* **Desire to optionally support AMSDU Fragmentation**
	+ **To allow more flexible design**

**CURRENT STATUS**

* **D0.5**
* **25.3 Fragmentation**
	+ **Language always refers to MSDU and MMPDU, not AMSDU**
	+ **i.e. AMSDU fragmentation is implicitly forbidden**
* **Baseline (REVmcD8.0)**
* **10.12 A-MSDU Operation**
	+ An A-MSDU shall be carried, without fragmentation, within a single QoS Data frame

**Rationales for existing restriction of A-MSDU fragmentation**

* **Just aggregated something, now fragment – seems counter productive**
* **Dynamic fragmentation includes a minimum fragment size**
	+ **Applied only to FIRST fragment**
	+ **Allows recipient to examine specific minimum number of bytes of MAC payload to identify L3/L4 header information**
		- **I.e. first N bytes of the MSDU**
		- **Allows MAC to select RX Buffer queue that is appropriate for the L3/L4 protocol at first fragment arrival**
	+ **This technique fails if the first fragment size applies to MPDU which contains more than one MSDU (i.e. A-MSDU)**
		- **Non-first MSDUs in the A-MSDU will not necessarily have the desired minimum fragment size of bytes lined up with the first bytes of MSDU payload**

**Contradiction with dynamic fragmentation**

* **For Level0, 1, 2, the restriction is effective**
* **For Level3 the restriction does not matter**
	+ **Level3 allows 4 fragments for a single MSDU to appear within a single AMPDU**
	+ **It is possible for a receiver to lose the first fragment (F0) of an MSDU but receive at least one of: F01, F02, F03 for the same MSDU**
		- **In this case, the receiver must buffer F01, F02, F03 in an intermediate location because it does not have L3/L4 header information available to identify the correct RX Buffer for this MSDU**
* **Level3 fragmentation already allows the behavior that the AMSDU restriction is intended to prevent**

**A-MSDU Fragmentation Proposal**

* **AMSDU fragmentation would be a recipient choice**
* **Complementary to Level0,1,2,3 selection**
* **Optional support**
* **Allows more choices at transmitter**
* **Transmitter can apply AMSDU aggregation without having to prevent fragmentation that might occur due to dynamic RU allocations**
* **If RU allocations are large, then transmitter prefers to use AMSDU to maximize performance**
	+ **E.g. small L3/L4 MSDUs, e.g. TCP ACK**
* **Because a transmitter cannot predict allocations**
	+ **The transmitter is forced to not use AMSDU**

**PROPOSED CHANGES:**

**9.4.2.218 HE Capabilities element**

**TGax Editor: *Add a new subfield to the HE Capabilities information element “A-MSDU Fragmentation Support”***

**TGax Editor: *Add a new row to Table 9-262z – Subfields of the HE MAC Capabilities Information field of subclause 9.4.2.218 HE Capabilities information element as shown:***

|  |  |  |
| --- | --- | --- |
| **Subfield** | **Definition** | **Encoding** |
| A-MSDU Fragmentation Support | The A-MSDU Fragmentation Support subfield indicates support for the reception of fragmented A-MSDUs.  | Set to 1 to indicate support for the receipt of fragmented A-MSDUs. Set to 0 to indicate that reception of fragmented A-MSDUs is not supported. |

**10.5 Fragmentation**

**TGax Editor: *Modify subclause 10.5 Fragmentation as shown:***

A STA shall be capable of receiving fragments, containing all or part of an MSDU, of arbitrary length that is less than or equal to the maximum MSDU size as specified in Table 9-19 (Maximum data unit sizes (in octets) and durations (in microseconds)).~~defined in 9.2.3 (General frame format), plus any security encapsulation overhead, plus MAC header and FCS~~.

**TGax Editor: *Modify the third paragraph of subclause 10.12 A-MSDU operation as shown:***

**10.12 A-MSDU operation**

An A-MSDU shall be carried, without fragmentation, within a single QoS Data frame, when the recipient has not indicated support for reception of fragmented A-MSDUs. An A-MSDU may be fragmented and each fragment transmitted within a single QoS Data frame, when the recipient has indicated support for reception of fragmented A-MSDUs. Support for reception of fragmented A-MSDUs is indicated with the Fragmented A-MSDU Support bit of the HE Capabilities element.

**TGax Editor: *Modify 25.3 Fragmentation subclause and its subclauses as shown:***

**25.3 Fragmentation**

**25.3.1 General**

An HE STA supports the static fragmentation procedure defined in 10.2.7 (Fragmentation/defragmentation overview), 10.5 (Fragmentation), and 10.6 (Defragmentation). In addition, an HE STA can support the dynamic fragmentation procedure defined in this subclause.

An HE STA can dynamically fragment individually addressed MSDUs, A-MSDUs or MMPDUs and defragment received MPDUs as defined in this subclause, and using the fragmentation/defragmentation processes defined in 10.2.7 (Fragmentation/defragmentation overview) without being subject to the rules defined in that subclause. Dynamic fragmentation provides further flexibility in aggregating the data so that padding can be minimized (see 25.5 (MU operation)).

**25.3.2 Support and requirements for dynamic fragmentation**

A dynamic fragment is an MPDU, the payload of which carries a portion of an MSDU, A-MSDU or MMPDU. The generation of dynamic fragments follows the rules defined in 10.2.7 (Fragmentation/defragmentation overview) and 10.5 (Fragmentation), except for:

— Generation of dynamic fragments and their transmission within an MPDU or A-MPDU under HT-immediate block ack agreements is allowed for an HE STA under the conditions defined in 25.3.4 (Procedure at the recipient).

— Reception of dynamic fragments is not mandatory. An HE STA declares its dynamic fragments reception capability in the HE Fragmentation Support field of the HE Capabilities element(#1471).

* + - * Fragmentation of A-MSDUs is permitted when the recipient supports it

— The length of each fragment is not required to be equal for all fragments of the MSDU, A-MSDU or MMPDU. The length of each fragment may be of any nonzero value, except that the length of the first fragment of an MSDU or A-MSDU shall be greater than or equal to the minimum fragment size specified by the receiver STA in the Minimum Fragment Size subfield of the HE Capabilities element it transmits. An MSDU or A-MSDU with a size that is less than the minimum fragment size shall not be fragmented.

**25.3.3 Procedure at the originator**

**25.3.3.1 General**

An originator STA transmitting an MPDU or A-MPDU that contains one or more dynamic fragments shall solicit an immediate response from the recipient STA for each of the fragments contained in the MPDU or A-MPDU, except when the fragments are sent under level 3 dynamic fragmentation (see 25.3.3.4 (Level 3 dynamic fragmentation)).

A STA shall not transmit a fragment containing all or part of an A-MSDU that is greater than the maximum A-MSDU size as specified in Table 9-19 (Maximum data unit sizes (in octets) and durations (in microseconds)).

NOTE—The originator STA sends the fragments in order as defined in 10.5 (Fragmentation), except for level 3 dynamic fragmentation.

If the originator STA received explicit indications in response frames that none of the transmissions of previously transmitted fragment(s) of an MSDU, A-MSDU or MMPDU have been successfully received then the STA may retransmit the full MSDU, A-MSDU or MMPDU instead of retransmitting all the failed fragments. Otherwise, the originator STA may retransmit the failed fragment, in which case the frame body length and contents of the retransmitted fragment shall be the same as the first transmitted fragment and shall remain fixed for the lifetime of the MSDU, A-MSDU or MMPDU at that STA.(#1225)

NOTE—An explicit indication is the absence of a valid Ack frame, BlockAck frame or Multi-STA BlockAck frame that is expected to be present in the first MPDU of the immediately received A-MPDU, or the absence of a BA Information field in the immediately received Multi-STA BlockAck frame for the TID of the transmitted fragment(s).(#1225) An originator STA shall not transmit to a recipient STA an MPDU or A-MPDU containing dynamic fragments that do not satisfy the conditions in the subclauses below.

**25.3.3.2 Level 1 dynamic fragmentation**

An originator STA may transmit to a recipient STA an MPDU(#1472) or VHT single MPDU(#1473) that contains one dynamic fragment of an MSDU or MMPDU if the recipient STA has indicated a value 1 in the HE Fragmentation Support field of its HE Capabilities element. An originator STA may transmit to a recipient STA an MPDU or VHT single MPDU that contains one dynamic fragment of an A-MSDU if the recipient STA has indicated a value of 1 in the A-MSDU Fragmentation Support field of its HE Capabilities element. The originator STA shall follow the rules defined in 10.13.8 (Transport of VHT single MPDUs) for generating the VHT single MPDU.

**25.3.3.3 Level 2 dynamic fragmentation**

An originator STA may transmit to a recipient STA, which has indicated a value 2 in the HE Fragmentation Support field of its HE Capabilities element, an MPDU, VHT single MPDU, or A-MPDU that contains:

— One dynamic fragment of an MSDU, A-MSDU if supported by the recipient, or MMPDU in an MPDU or VHT single MPDU(#1474)

• The originator STA shall follow the rules defined in 10.13.8 (Transport of VHT single MPDUs) for generating the VHT single MPDU

— Up to one dynamic fragment of an MSDU, A-MSDU if supported by the recipient, or MMPDU for each MSDU or A-MSDU and for an MMPDU in an A-MPDU format.

The originator STA shall follow the rules defined in 10.24.7.7 (Originator’s behavior) for gener-ating the A-MPDU and the rules defined in 25.10.4 (A-MPDU with multiple TIDs) for generat-ing the multi-TID A-MPDU (that can contain the fragment of the MMPDU)

**25.3.3.4 Level 3 dynamic fragmentation(#1484)**

An HE STA may transmit an L3 Frag BA Request frame to a receiver STA that has indicated a value of 3 in the HE Fragmentation Support field of the HE Capabilities element it transmits. The receiver STA that accepts the HT-Immediate block ack session shall respond with an L3 Frag BA Response if it has allocated resources for operating in a block ack session with level 3 fragmentation enabled. Otherwise, it shall respond with a BA Response frame to indicate that it has not allocated resources for operating in a block ack session where level 3 fragmentation is enabled.(#2268)(#2198)(#1800)(#1796)(#1663)

NOTE—A block ack session with level 3 fragmentation enabled requires a block acknowledgment record that maintains up to 4 bits per MSDU (one bit for each fragment of the MSDU).(#2268)(#2198)(#1800)(#1796)(#1663)

An originator STA may transmit to a recipient STA, which has indicated a value 3 in the HE Fragmentation Support field of its HE Capabilities element, an MPDU, VHT single MPDU, or A-MPDU(#1473) that contains:

 — One dynamic fragment of an MSDU, A-MSDU if supported by the recipient, or MMPDU in an MPDU or VHT single MPDU(#1474)

• The originator STA shall follow the rules defined in 10.13.8 (Transport of VHT single MPDUs) for generating the VHT single MPDU

— Up to four dynamic fragments of an MSDU(#1475) for each MSDU and up to one dynamic fragment of an MMPDU(#1476)(#1475)(#2465) in an A-MPDU, and up to four dynamic fragments of an A-MSDU for each A-MSDU if supported by the recipient

• The originator STA shall set the Fragment Number subfield of each MPDU to a value less than 4

• The originator STA shall follow the rules defined in 10.24.7.7 (Originator’s behavior) for gener-ating the A-MPDU with the exception that the A-MPDU shall contain MPDUs whose range of the Sequence Number subfields does not exceed *BL*/4, where *BL* is the length of the Block Ack Bitmap field of the BlockAck or Multi-STA BlockAck(#Ed) frame that corresponds to a TID of a transmitted fragment (see 10.24.7 (HT-immediate block ack extensions) and 25.4 (Block acknowledgement).(#697)(#Ed)(#166)(#1818)

**25.3.4 Procedure at the recipient**

**25.3.4.1 General(#Ed)**

An HE STA shall set the HE Fragmentation Support subfield of the HE Capabilities element it transmits to 0 if its dot11HEDynamicFragmentationImplemented is false. Otherwise the HE STA shall set the HE Fragmentation Support subfield as follows:

— Set to 1 if the STA supports reception of dynamic fragments following the procedure defined in 25.3.3.2 (Level 1 dynamic fragmentation(#1484))

— Set to 2 if the STA supports reception of dynamic fragments following the procedure defined in 25.3.3.3 (Level 2 dynamic fragmentation(#1484))

 — Set to 3 if the STA supports reception of dynamic fragments following the procedure defined in 225.3.3.4 (Level 3 dynamic fragmentation(#1484)) (#1481)(#424)Defragmentation of dynamic fragments shall follow the rules defined in 10.6 (Defragmentation) with the following exceptions:(#Ed)

 — The recipient STA shall support the concurrent reception of dynamic fragments of a number of *outstanding* MSDUs, A-MSDUs when supported and MMPDUs from a transmitting STA that is equal to *Nmax*, where *Nmax* for MSDUs is indicated in the Maximum Number of Fragmented MSDUs subfield of the HE Capabilities element transmitted by the STA, and *Nmax* is equal to 1 for MMPDUs. The term *outstanding* refers to an MPDU containing all or part of an MSDU or MMPDU for which transmission has been started, and for which delivery of the MSDU, A-MSDU or MMPDU has not yet been completed (i.e., an acknowledgment of the final fragment has not been received and the MSDU, A-MSDU or MMPDU has not been discarded due to retries, lifetime, or for some other reason). (#1482)(#697)(#167)(#1484)

— The recipient STA is not subject to the receive timer rules(#1483) for each of the MSDUs/A-MSDUs/MMPDUs defined in 10.6 (Defragmentation)(#2318).

A STA that has a value of true for dot11AMSDUFragmentationOptionImplemented shall set the A-MSDU Fragmentation Support subfield to 1 in transmitted HE Capability elements. Otherwise, the STA shall set the A-MSDU Fragmentation Support subfield to 0 in transmitted HE Capability elements.

A STA with a value of true for dot11AMSDUFragmentationOptionImplemented shall be capable of receiving fragments containing all or part of an A-MSDU of arbitrary length that is less than or equal to the maximum A-MSDU size as specified in Table 9-19 (Maximum data unit sizes (in octets) and durations (in microseconds)).

**25.3.4.2 Level 1 dynamic defragmentation**

Upon reception of an MPDU or VHT single MPDU that carries one or more dynamic fragments, the recipient STA responds with an Ack frame when the received fragment is contained in an MPDU or VHT single MPDU that solicits the immediate response. The receiver STA shall follow the rules defined in 10.3.2.9 (Ack procedure) for generating the Ack frame and the rules defined in 25.4 (Block acknowledgement) for generating the Multi-STA BlockAck frame that contains the acknowledgement for the soliciting VHT single MPDU carried in a Trigger-based PPDU(#1793)(#2628).

**25.3.4.3 Level 2 dynamic fragmentation**

Upon reception of an MPDU or A-MPDU that carries one or more dynamic fragments, the recipient STA responds with one of the following frames:

 — An Ack frame when the received fragment is contained in an MPDU or VHT single MPDU that solicits the immediate response. The recipient STA shall follow the rules defined in 10.3.2.9 (Ack procedure) for generating the Ack frame and the rules defined in 25.4 (Block acknowledgement) for generating the Multi-STA BlockAck frame that contains the acknowledgement for the soliciting VHT single MPDU carried in a HE trigger-based PPDU(#1793)(#2628).

 — A BlockAck frame when the received fragments, up to one fragment for each MSDU or A-MSDU, are contained in an A-MPDU that solicits an immediate response(#1820)(#1485). The recipient STA shall follow the rules defined in 10.24.7.5 (Generation and transmission of BlockAck frames by an HT STA or DMG STA) for generating the BlockAck frame and the rules in 25.4 (Block acknowledgement) for generating the Multi-STA BlockAck frame(#1793), except that the STA shall:

• Set to 0 the LSB of the Fragment Number subfield in the Block Ack Starting Sequence Control subfield of the BlockAck frame or Multi-STA BlockAck(#Ed) frame that corresponds to a TID of a received fragment(#967)

 • Set to 1 each bit of the Block Ack Bitmap field that corresponds to a Sequence Number subfield and TID subfield of a successfully received fragment contained in the soliciting A-MPDU or multi-TID A-MPDU

• Update the corresponding block ack record(#1486)(#Ed) only when an MSDU or A-MSDU that is received in fragments is successfully reconstructed (see 10.6 (Defragmentation)) otherwise it shall not update the block ack record(#Ed) for that MSDU or A-MSDU.(#1793)(#1217) A recipient STA shall discard any fragments that have been received during an HT-immediate BA session for a TID if it receives a BlockAckReq(#Ed) frame from the originator STA for that TID when the fragments have a Sequence Number field value that is less than the value of the Starting Sequence Number field of the BlockAckReq(#Ed) frame (where the comparison of the two values is performed modulo 4096)(#1662)(#2197)(#1217).

**25.3.4.4 Level 3 dynamic fragmentation**

Upon reception of an MPDU or A-MPDU that carries one or more dynamic fragments, the recipient STA responds with one of the following frames:

— An Ack frame when the received fragment is contained in an MPDU or VHT single MPDU that solicits the immediate response. The recipient STA shall follow the rules defined in 10.3.2.9 (Ack procedure) for generating the Ack frame and the rules defined in 25.4 (Block acknowledgement) for generating the Multi-STA BlockAck frame that contains the acknowledgement for the soliciting VHT single MPDU carried in a Trigger-based PPDU(#1793)(#2628).

— A BlockAck frame when the received fragments, one or more fragments for each MSDU, or A-MSDU are contained in an A-MPDU where at least one MPDU's Fragment Number field is of non-zero value(#2268) that solicits the immediate response and is sent during a BA session that was setup with an L3 FRAG ADDBA Response frame(#2268). The recipient STA shall follow the rules in 10.24.7.5 (Generation and transmission of BlockAck frames by an HT STA or DMG STA) for generating the BlockAck frame, except that the STA shall:

 • Set to 1 the LSB of the Fragment Number subfield in the Block Ack Starting Sequence Control subfield of the BlockAck frame or Multi-STA BlockAck frame that corresponds to a TID of a received fragment

 • Set to 1 each bit in position(#1488) *B*(#633) of the Block Ack Bitmap field that corresponds to a successfully received fragment and shall set it to 0 otherwise, with *B*(#633) calculated as: *B* = 4 *(SN* – *SSN) + FN*, where the operations on the sequence numbers are performed module 4096(#675)(#2270)(#2254)(#1624)(#1491)(#1489) *SN* is the value of the Sequence Number subfield of an MPDU containing the fragment for which the receive status is indicated *SSN* is the value of the Starting Sequence Number subfield of the Block Ack Starting Sequence Control subfield of the BlockAck frame

 • Update the corresponding block ack record(#1486) only when an MSDU or A-MSDU that is received in frag-ments is successfully reconstructed (see 10.6 (Defragmentation)). Otherwise it shall not update the block ack record for that MSDU or A-MSDU.(#1793)(#1217) The(#Ed) recipient STA shall discard any fragments that have been received during an HT-immediate BA session for a TID if it receives a BlockAckReq(#Ed) frame from the originator STA for that TID when the fragments have a Sequence Number field value that is less than the value of the Starting Sequence Number field of the BlockAckReq(#Ed) frame (where the comparison of the two values is performed modulo 4096)(#

**TGax Editor: *Add a new MIB variable in C.3 MIB Detail within the dot11HEStationConfigEntry group as shown:***

**C.3 MIB Detail**

dot11AMSDUFragmentationOptionImplemented OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This is a capability variable. Its value is determined by device capabilities.

This attribute, when true, indicates that the STA implementation is capable of receiving dynamic fragments of A-MSDUs. The capability is disabled, otherwise"

DEFVAL { false }

::= { dot11HEStationConfigEntry <XX>}