Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**MAC Header Design to support Multiplexing scheme in 16m**
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Re:	TGm SDD: 10.12.1 MAC Header Formats
Abstract	SDD text proposal on 16m Headers
Purpose	For discussion and adoption in 802.16m SDD
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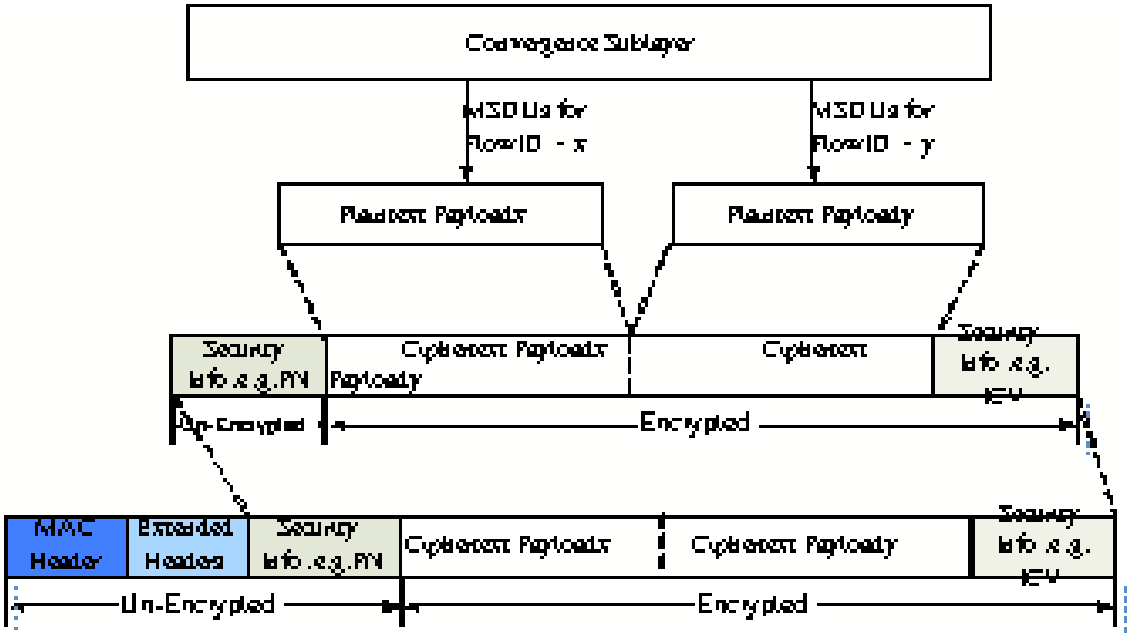
MAC Header Design to support multiplexing Scheme

1 Introduction

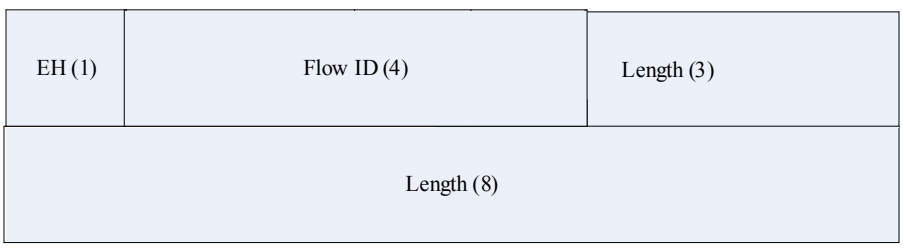
In section 10.12 of SDD, It say's "multiple MAC SDUs and/or SDU fragments from different unicast connections belonging to the same AMS can be multiplexed into a single MAC PDU."

Also Figure 20 of 10.6.5.1.3 explains the multiplexing of payload from different flows into one MAC PDU.



All the payload of the active connections per MS is packed in one single MAC PDU. Encryption is applied on the entire payload. Security information may be located in one of the extended header.

In the current GMH designed in section 10.12 does not have Header Type field therefore any new feature such as multiplexing or even fragmentation and packing for single flow has to be done through extended Header. It is expected that 90% of the time, SDUs are either fragmented or packed together. Therefore require extended Header to support fragmentation and packing. This leads to a overhead of almost ½ bytes is always present. This extended Header adds additional overhead because of shortcoming of Header design in section 10.12.

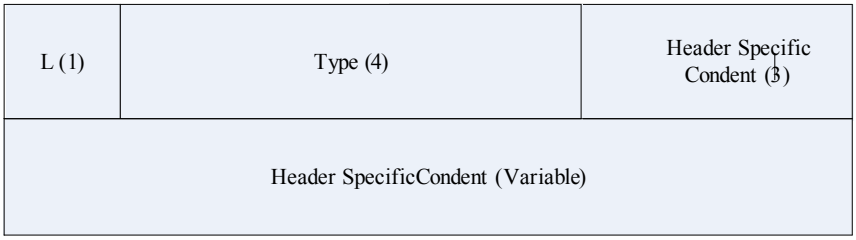


Fragmentation/Packing Extended Header scheme was proposed in C80216m-09/0017, which is very similar to MEHB design described in section 2.1.1 except it only deals with one connection and does not contain Flow ID (Flow ID is part of GMH).

In most of the cases, only VoIP traffic will not be fragmented or packed. However, VoIP traffic will be transmitted using either persistent allocation or GRA allocation where more efficient header (1 byte) can be designed as explained in contribution C80216m-09/447.

From current GMH design, It is not clear how the SDUs from multiple connections are packed using 2 bytes GMH. If no multiplexing is supported and only SDUs of single flow is packed in one MAC PDU then MAC Header overhead will be further increased.

This contribution compares the overhead comparison of 2 bytes GMH in SDD with the proposed MAC Header design.
Extended Header design as defined in SDD is following:



2 Proposed MAC Header Design

We propose to have a 1 byte GMH where 2 bit HT (Header Type) in the GMH will distinguish different Header types.

HT = 0b01 indicate multiplexing MAC Header

The format of **GMH header** is shown below:

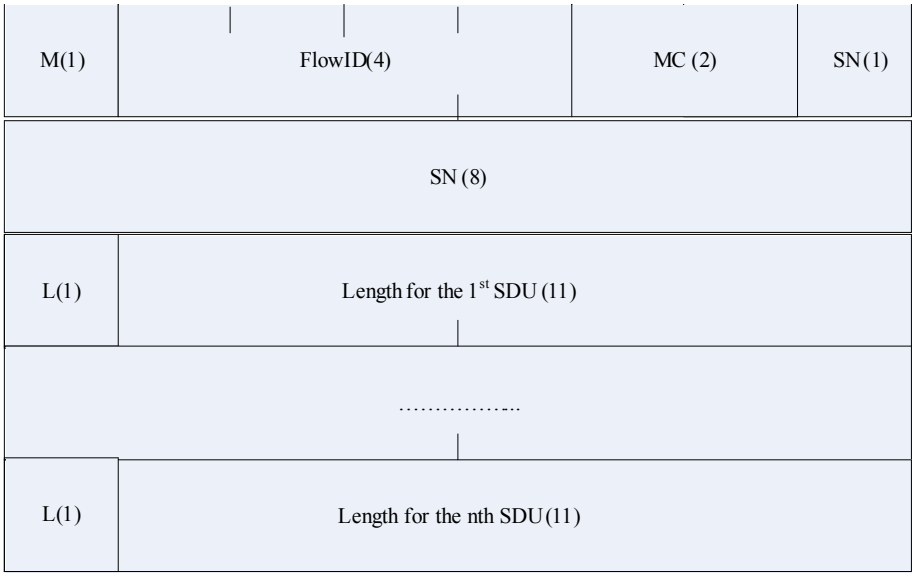
If HT = 01, then **multiplexing extended header** is attached right after the GMH header. No separate Extended

Header is required to indicate the present of multiplexing extended header. The EH bit indicates if there are more extended headers after the multiplexing extended header.

2.1.1 Multiplexing Extended Header Block (MEHB)

As shown in the following figure, Multiplexing Extended header contains multiple Multiplexing Extended Header Blocks (MEHB). The SDUs belonging to the same connection are packed together and the information related to these SDUs is included in one MEHB. The M bit in MEHB indicates if there is more MEHB followed.

The format of MEHB is shown below (except the flow ID is not present in the first MEHB:



M (1bit): indicate if there is more MEHB follows
Flow ID (4 bit): flow id of the SDUs identified in the MEHB
MC (2) = Flow control field
SN (9): ARQ BSN for ARQ enabled connection or Fragment SN for non-ARQ enabled connection
L (1bit): indicate if there is more length field follows
Length: length for each SDU identified in the MEHB

3 Overhead Analysis:

This section compares the MAC PDU overhead between the proposed scheme and current GMH with FPEH defined in 80216m-09/0017.

Parameters: for single flow

Parameter	Value	Note
% of CMH Usage	50	% of Compact MAC Header Usage (persistent allocation)
% of GMH Usage	100 - % of CMH Usage	% of GMH usage (Rest of the transmission using GMH)
% of MPDU with Fragmentation Header	80	
% of MPDU with Packing Header	10	
Avg # of packed SDUs in one MPDU	3	
Avg # of Packed SDU fragments per MAC PDU	1	

Parameters: for multiple Flows

# of Flows	2	SDUs from multiple flows
Probability of have SDUs from multiple flows	20%	

Following Table describes the # of bytes required for Headers and extended headers and also **compare the overhead per MPDU for a single connection**. (Byte alignment is performed for all MAC Headers).

Companies	GMH	CMH	Fragmentation (FSH)	Packing (SFH)		Overhead in case of multiple Flow (Bytes)	Overhead in case of single flow(Bytes)
SDD + FPEH of C80216m-09/0017	2	1	3	6		3.5	3.0
Proposed Design	1	1	3	6		2.9	2.6

4 Conclusion

- It can be seen from the overhead point of view, proposed MAC Header Design has least overhead (**Overhead is almost 1/2 byte less in proposed GMH Design**)

- Overhead is calculated for both one connection (where SDUs or SDU fragments of single connections are packed together) and multiple connections (where SDUs or SDU fragments of multiple connections are packed together). In both the cases proposed GMH design has less overhead. Efficiency of propose design increase if more flows are multiplexed orhigher probability of multiple flows are packed together.

- Proposed GMH design provides future extendibility by having 2 bits Header Type and 1 bit reserved in GMH.

5 Text Proposal

========== *Start of Proposed Text* ==========

[Delete section 10.12.1.1]

[Insert following section and text as section 10.12.1.1]

10.12.1.1 Generic MAC Header

The format of **GMH header** is shown below:

- HT (Header Type) : Length of HT is 2 bit.

  0b01 = GMH Header
  0b10 = Signaling MAC Header

  00 and 11 are reserved.

- EH (Extended Header presence indicator): When set to '1", this field indicates that an Extended Header is present following this GMH.

- FlowID (Flow Identifier): This field indicates the service flow that is addressed.. This field is 4bits long

[Insert new section 10.12.2.2 and text as follows]
10.12.2.2 Multiplexing Extended Header (MEH)

If HT = 01, then **multiplexing extended header** is attached right after the GMH header. No separate Extended Header is required to indicate the present of multiplexing extended header. The EH bit indicates if there are more extended headers after the multiplexing extended header.

As shown in the figure x, Multiplexing Extended header (MEH) contains multiple Multiplexing Extended Header Blocks (MEHB). The SDUs or SDU fragments belonging to the same connection are packed together and the information related to these SDUs is included in one MEHB. The M bit in MEHB indicates if there is more MEHB followed.

If the SDUs or SDU fragement(s) included belong to the one connection, only one MEHB is present.

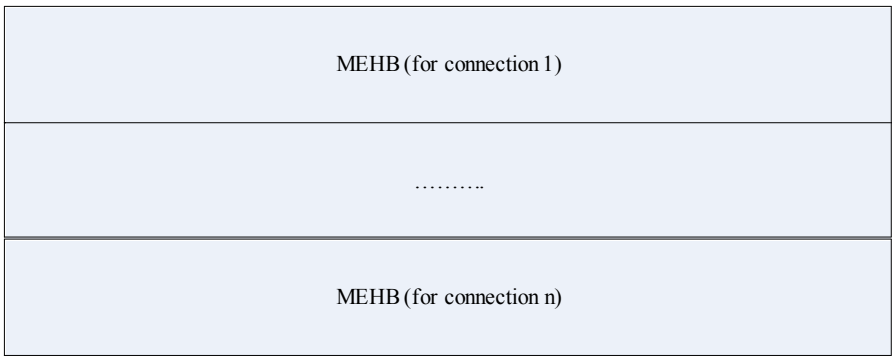


Figure x: Format of Multiplexing Extended Header (MEH)

The format of MEHB is shown in Figure y, except the first MEHB.

The first MEHB doesn't contain the Flow ID and the length for the first SDU associated with the Flow ID. The Flow ID and the Length fields in the generic MAC header represent the flow ID associated with the first MEHB and the length of the first SDU associated with the first MEHB.

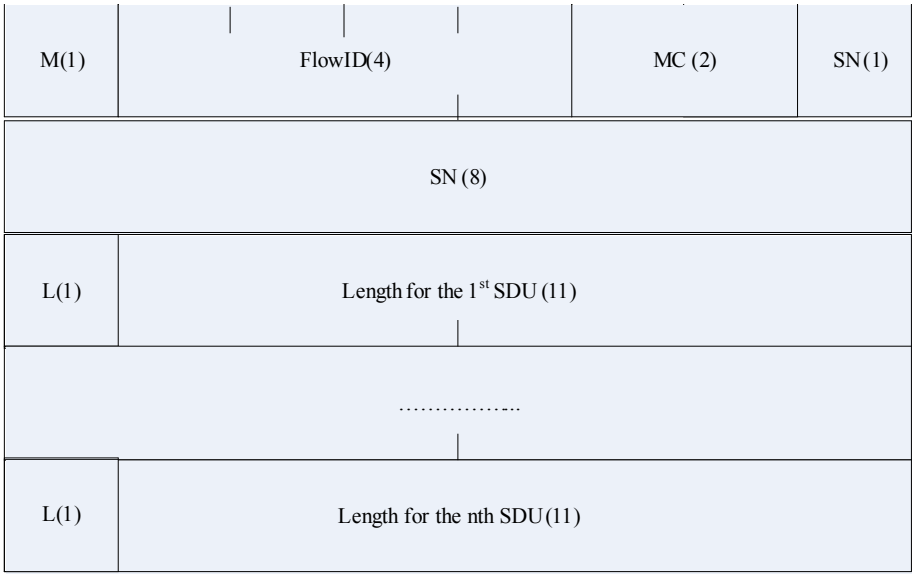


Figure y: Format of Multiplexing Extended Header Block (MEHB)

M (1bit): Indicate if there is more MEHB follows
Flow ID (4 bit): Flow id of the SDUs identified in the MEHB. (Flow ID is not present in the first MEHB)
MC (2): Multiplexing Control Information (as shown in Table z).
SN (9): ARQ SN for ARQ enabled connection or Fragment SN for non-ARQ enabled connection
L (1bit): Indicate if there is more length field follows
Length: Length for each SDU identified in the MEHB

MC	Meaning	Examples
00	The first byte of data in the payload is the first byte of a MAC SDU. The last byte of data in the payload is the last byte of a MAC SDU.	One or Multiple Full SDUs packed in the payload
01	The first byte of data in the payload is the first byte of a MAC SDU. The last byte of data in the payload is not the last byte of a MAC SDU.	a) payload with only First fragment of an SDU; b) payload with one or more unfragmented SDUs, followed by first fragment of subsequent SDU

10	The first byte of data in the payload is not the first byte of a MAC SDU. The last byte of data in the payload is the last byte of a MAC SDU.	a) payload with only Last fragment of an SDU; b) payload with Last fragment of an SDU, followed by one or more unfragmented subsequent SDUs
11	The first byte of data in the payload is not the first byte of a MAC SDU. The last byte of data in the payload is not the last byte of a MAC SDU.	a) payload with only middle fragment of an SDU; b) payload with Last fragment of an SDU, followed by zero or more unfragmented SDUs, followed by first fragment of a subsequent SDU

Table z: Multiplexing Control Information

========== *End of Proposed Text* ==========