Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>	
Title	**IEEE 802.16m MAC Header and Sub-Header Structure C80216m-08/1040r1**	
Date Submitted	**2008-09-08**	
Source(s)	Yair Bourlas, Lei Wang, Erik Colban NextWave Wireless	Voice: E-mail: ybourlas@nextwave.com *<http://standards.ieee.org/faqs/affiliationFAQ.html>
Re:	MAC Data Plane	
Abstract	This contribution proposes a new 802.16m MAC header and MAC sub-header	
Purpose	Discussion and approval by TGm for the 802.16m SDD	
Notice	*This document does not represent the agreed views of the IEEE 802.16 Working Group or any of its subgroups*. It represents only the views of the participants listed in the "Source(s)" field above. It is offered as a basis for discussion. It is not binding on the contributor(s), who reserve(s) the right to add, amend or withdraw material contained herein.	
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.	
Patent Policy	The contributor is familiar with the IEEE-SA Patent Policy and Procedures: <http://standards.ieee.org/guides/bylaws/sect6-7.html#6> and <http://standards.ieee.org/guides/opman/sect6.html#6.3>. Further information is located at <http://standards.ieee.org/board/pat/pat-material.html> and <http://standards.ieee.org/board/pat>.	

Outline

- This contribution covers the following aspects related to 802.16m Upper MAC Data Path:
  - MAC Header
  - MAC Sub-header
  - Fragmentation procedure
  - Packing procedure

Introduction

- The SDD (C802.16m-08/003r4) defines two types of logical addresses: “Station Identifier” and “Flow Identifier” addresses.
- The station Identifier uniquely identifies the MS within the addressing scope of a single base station.
- The Flow Identifier uniquely identifies a flow within the addressing scope of the MS.
- Based on these agreements, the 802.16e 16-bits CID construct is no longer needed in 802.16m, and thus providing an opportunity for a MAC header redesign to reduce the overhead of the MAC header.

Generic MAC Header in the Legacy System

- Fields which can be removed or reduced in size
  - **EC** and **EKS** are used to support link level encryption for all packets regardless of whether encryption is used or not. We can move this information to a sub-header so that it is included only when the PDU is encrypted
  - **Type** field is used to indicate the presence of specific sub-headers; this field can be removed; all 802,16m sub headers can be indicated in a manner similar to the extended sub-header (ESF) indicator with a one bit indicator.
  - CI is used to indicate the inclusion of MAC level CRC (CRC-32); the indication can be removed since a PHY level CRC is used.
  - **HCS** (CRC-8): can be removed since a PHY burst CRC is used for all PHY transmission
  - The size of the **CID field** can be reduced since the addressing scope need only be unique within the MS;

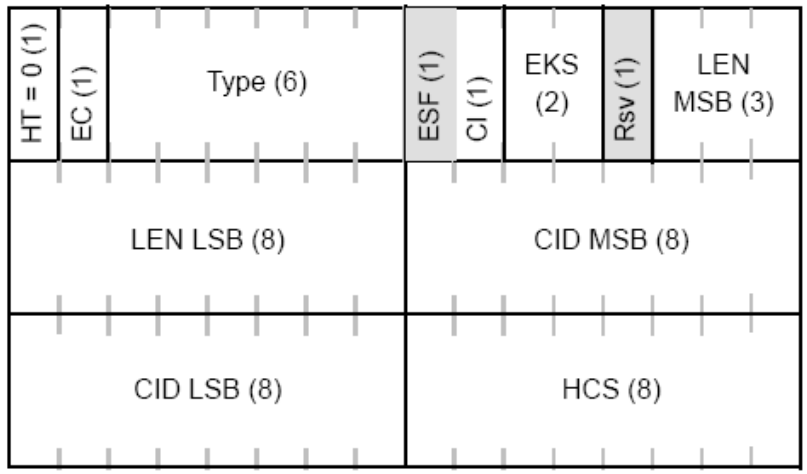
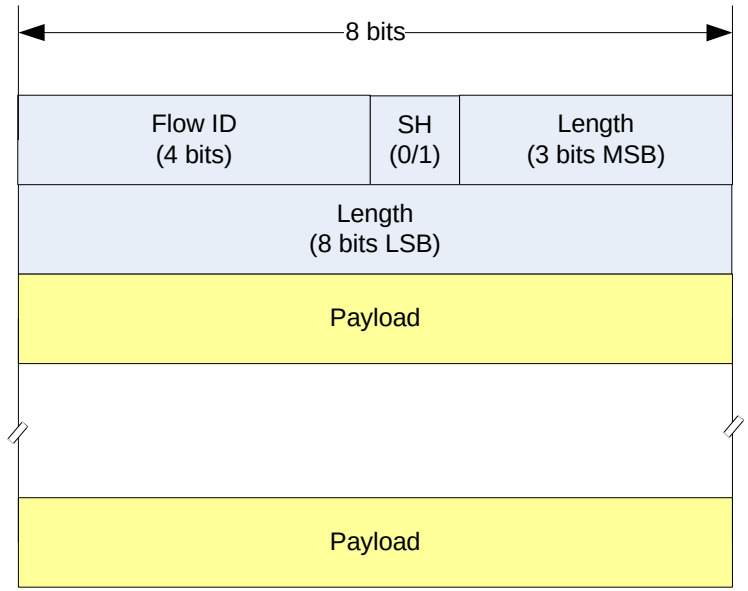


Figure 23—Generic MAC header format

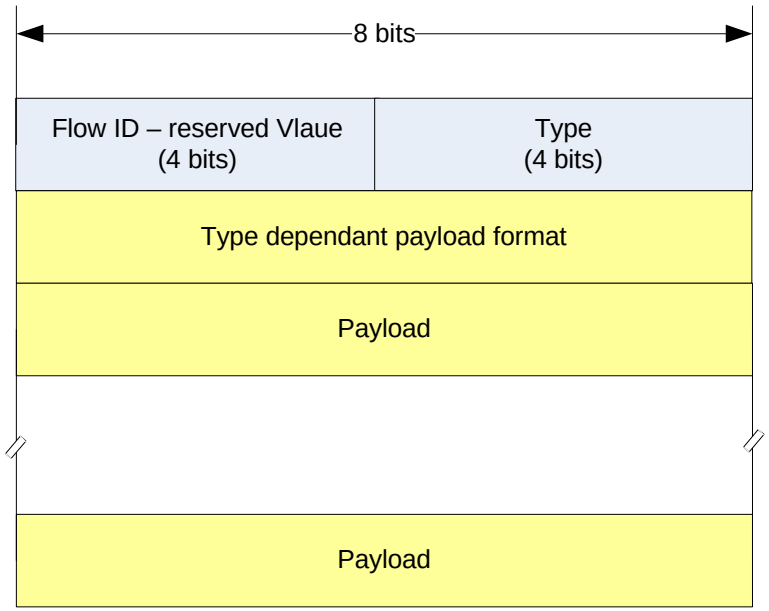
Proposed 802.16m MAC Header Format

- MAC header fields:
  - Flow ID – 4 bits
    - Well-known Flow IDs values are reserved to indicate MAC management flows, e.g. basic (0b0000) and primary (0b0001);
    - A well-known Flow ID value is reserved to indicate Signalling MAC Header (SMH)
    - This allows the system to support up to 13 MAC traffic flows per MS per direction
  - Sub-header indication – indicates the presence of sub-headers:
    - E.g. fragmentation and encryption information
  - Length – 11 bits

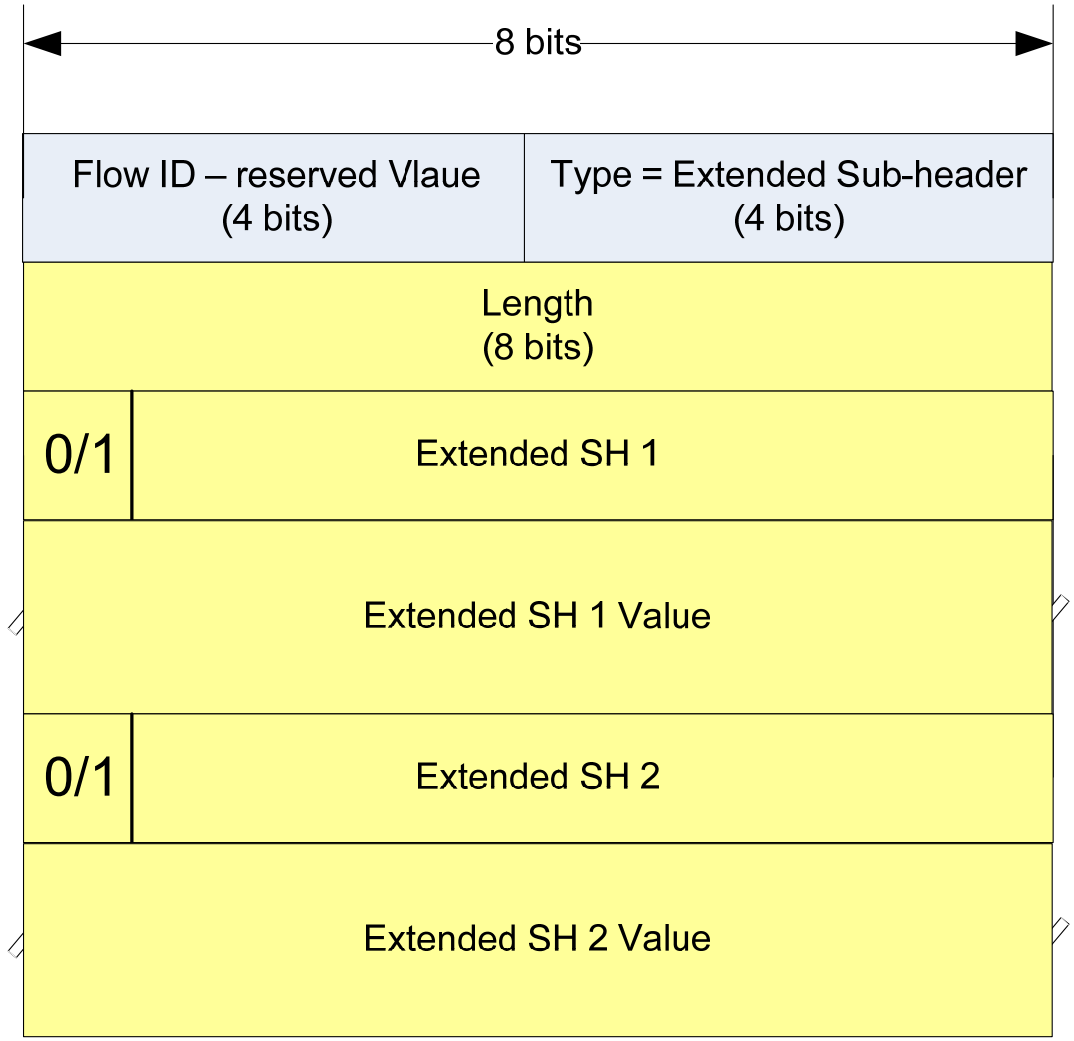


Proposed 802.16m Signalling MAC Header Format

- Signalling MAC Header fields
  - A reserved well-known Flow ID value is use to indicate the Signalling MAC Header (SMH) (e.g. 0b1111)
  - The Type field indicates the specific format of the Signalling MAC Header; several signalling MAC headers types may be defined, e.g. fixed length signalling MAC header for bandwidth requests or a variable length type with a shorter length field.
  - An extended type Signalling MAC header can be defined by reserving a well-known type value for additional less frequently used signalling MAC header types. Note however that extending Signalling MAC header type beyond 4 bits will result in similar efficiency of using a MAC message with the basic flow ID.



Example of Signalling MAC Header transporting Legacy system extended sub-headers



Sub-header: Fragmentation and Encryption

- Motivation for redesigning the fragmentation Sub-header
  - The legacy system carries the following information in the fragmentation sub-header
    - FC (2b) indicates fragmentation state: not fragmented; first, continue, and last; there is no value of signalling, ***first, continue*** and ***last***, since ***continue*** always follows ***first***, and ***last*** always follows ***continue***.
    - A 1 bit FC indicating a ***last/not-last*** fragment can provide the same information; a 1 bit FC adds negligibly to the residual packet error rate after reassembly.
  - FSN (3b or 11b)
  - Fragmentation Sequence Number (FSN) can also be used for the ARQ window size (see related contribution C80216m-08/XXX)
    - A 3 bits FSN is too small; 11 bit FSN (or BSN) is way too large
    - A 6 bit FSN seems right and it can fit into a one byte Sub-header carrying both encryption and fragmentation information.
      - With a 6 bits FSN, an ARQ window size of 16K bytes can be supported assuming an average PDU size of 256 bytes

802.16m MAC Sub-header with fragmentation and encryption information

- 16m modifications to support 1 byte Sub-Header:
  - Remove the EC indicator – a connection is either always encrypted or never encrypted; determined at connection establishment
  - Use 1 bit EKS, allowing for 2 active keys per connection; the EKS field is ignored if the connection is not encrypted
  - Use 1 bit FC indicating ‘last/not-last’ packet;

EKS (1b)	**FC (1b)**	**FSN (6b)**

Packing

- The Legacy system supports packing of multiple SDUs within one MAC PDU.
  - The motivation for introducing the packing procedure in the legacy system was to save on the GMH overhead.
  - In the Legacy system, the packing procedure saves 3 bytes compared to SDU concatenation
- The 16m system significantly reduces the size of the MAC header (as shown in previous slides), thus removing the motivation to support the packing procedure.
- Removing the packing procedure in 16m will result in a simpler system consistent with the SRD requirement of section 5.2 which stipulates that IEEE 802.16m should avoid excessive system complexity.

Proposed SDD Text (1/4)

10.x MAC Headers and Sub-Headers

10.x.1 MAC Headers

Two types of MAC headers are defined: Generic MAC header (GMH) and Signaling MAC Header (SMH). These are described in the following sections.

10.x.1.1 Generic MAC Header

The Generic MAC Header has the following fields:

- Flow ID (4 bits). Well-known Flow ID values are reserved to indicate MAC management flows, e.g. basic (0b0000) and primary (0b0001). An addition a well-known Flow ID value is reserved to indicate a Signaling MAC Header (SMH) type. This allows the system to support up to 13 MAC traffic flows per MS per direction
- Sub-header indication (1 bit) – indicates the presence of sub-headers, e.g. fragmentation and encryption information
- Length (11 bits) – indicating the length of the PDU

Proposed SDD Text (2/4)

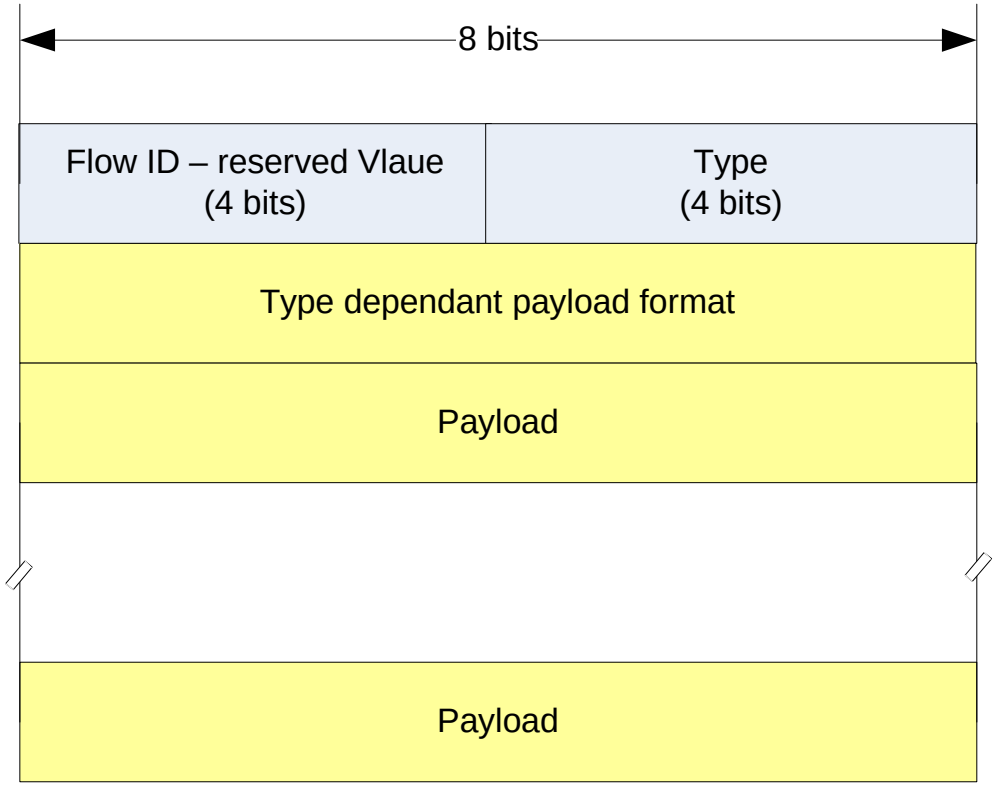


Figure XXX: 802.16m Generic MAC Header

Proposed SDD Text (3/4)

10.x.1.2 Signaling MAC Header (SMH)

The Signaling MAC Header is indicated using a well-known Flow ID value (e.g. 0b1111). The Type field of the MAC signaling header indicates the specific format of the Signaling MAC Header.

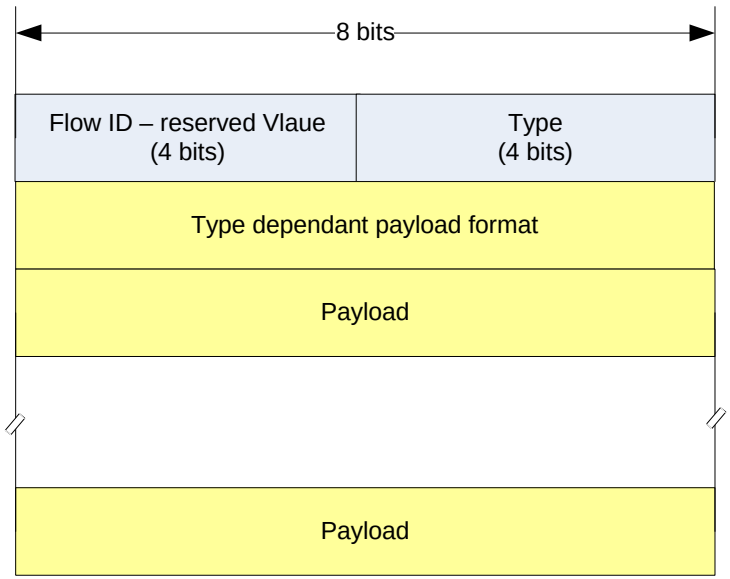


Figure XXX: 802.16m Signaling MAC Header

Proposed SDD Text (4/4)

10.x.2 Sub-Header

The sub-header carries fragmentation and encryption information as follows:

- EKS (1b), allowing for 2 active keys per connection. The EKS field is ignored if the connection is not encrypted.
- FC (1b) indicating 'last/not-last' PSU. The 16m Fragmentation and encryption Sub-Header is show in the figure below.

Note that the packing procedure as defined in the Legacy System is not supported in the 802.16m system.

EKS (1b)	FC (1b)	FSN (6b)

Figure XXX: 802.16m MAC Sub-Header