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Re:	Call for Comments on Project 802.16m SDD (IEEE802.16m-08/052) 10.12 in IEEE 802.16m-08/003r6 (MAC PDU Formats) 10.6.5.1.2 in IEEE 802.16m-08/003r6 (Multiplexing MPDUs)
Abstract	This contribution includes a proposal for burst structure, PDU structure, Multiplexed PDU structure, and related header formats for IEEE 802.16m MAC. The proposal gives simplified and unified structures for the burst and PDU. Also, the proposed format gives full flexibility to add new signaling messages.
Purpose	To review and adopt the proposed text to the SDD
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Proposal for Burst, PDU Structure, and Header Formats

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POSDATA

1. Introduction

MAC header of the 802.16e is complicated and less efficient because its format was updated mainly by adding new features to the pre-defined format of the 802.16-2004. Therefore, there is a possibility to have a more efficient and simplified MAC header format for the 802.16m system.

The purpose of this proposal is as follows:

- Make simplified and transparent format for MAC PDUs
- Make the number of MAC header formats as small as possible
- Reduce overhead on PDUs and bursts

2. Design Considerations

2.1 Burst Identification

In legacy systems, when MS receives the data it checks whether the MAC PDU in the burst is for itself by verifying the CID in the MAC PDU header, however, in 802.16m system, the MAC PDU header has only flow identifier and there is no information about its destination. To solve this problem, we introduce 'subburst' concept for the burst. In other words, the burst is divided into several subbursts and each subburst is equal to unicast burst. In this proposal, one of the following mechanisms is assumed to be implemented, to notify the destination and the size of each subburst.

- The USCCH has the information on Station ID and the size for each subburst one by one, whose order follows the order of subburst in the burst. This is similar to the HARQ DL MAP IE in the 802.16e system.
- The USCCH has the information on Station ID for each subburst one by one, whose order follows the order of subburst in the burst. Also, the burst header has the information on the size for each subburst one by one, whose order is accorded with the order of subburst in the burst.

In any of the two methods, the size of subburst is known to the destination MS.

2.2 Length Field in GMH

The harmonized SDD for headers (C80216m-08_1410r3) defines GMH has the Length field to give the size of the MAC PDU. However, the length of the MAC PDU can be known if the size of subburst is known. Therefore, the information in the length field of GMH may be removed if we adopt the subburst concept for transmission. Instead for packing and fragmentation, Packing subheader and Fragmentation subheader need the Length field, however, those two subheader format can be merged into one.

2.3 Minimize the Number of MAC Header Types

Increasing the number of MAC header types makes complicate the PDU processing at the receiver and needs more bits, for example HT field in GMH is used to differentiate the MAC header types. Therefore, it is important to minimize the number of MAC header types. The harmonized SDD for headers (C80216m-08_1410r3) shows five types of MAC headers including Generic MAC Header (GMH), Compact Header, Multicast/Broadcast MAC Header, Signaling MAC Header, and Extended Header. There may be also subheaders including fragmentation subheader and packing subheader. Among these, Multicast/Broadcast MAC Header can be differentiated by its Station ID, Compact Header is not required if the current GMH is reduced further, Signaling MAC Header can be merged with Extended Header because of its similar characteristics and these two headers can be implemented using subheaders because of its small size. Then, only GMH format is required.

2.4 MAC Signaling Header Type I, II and Extended Subheader in Legacy System

All the signaling header type and extended subheader defined in the 802.16e system can be merged into one signaling subheader and several signaling information may be transmitted using the same PDU. This gives better flexibility to carry the signaling information than using the signaling MAC header which may have a fixed size. Because of the flexibility of the size, it is possible to effectively design the format of each signaling information and to easily add new formats of signaling information in future.

2.5 Compact Type Payload subheader

In case of small size SDUs, e.g. VoIP packet, it is more important to reduce the header overhead. To meet this requirement, Compact Payload subheader (CPSH) is proposed whose size is just one byte. To make the size of CPSH one byte, the length field becomes 6 bits, however, the 6bit length may not be sufficient in some cases. To solve this problem, we add concept of basis length value (BLV). Section 4 describes the details of BLV.

3. Proposed Burst Format

Based on the above consideration, following burst format is proposed. The burst consists of the optional Burst Header field and several subbursts. The Burst Header field contains the length of each subburst whose unit may be Logical Resource Unit (LRU), however, the Burst Header field may be removed if the USCCH contains the length information of each subburst. As a special case, unicast burst does not need the Burst Header field because USCCH has already contains the length of the burst. The format for unicast burst is the same as the burst with a single subburst. Each subburst contains one or multiple PDUs with padding and CRC. That is, CRC is attached per subburst for further reducing the overhead.

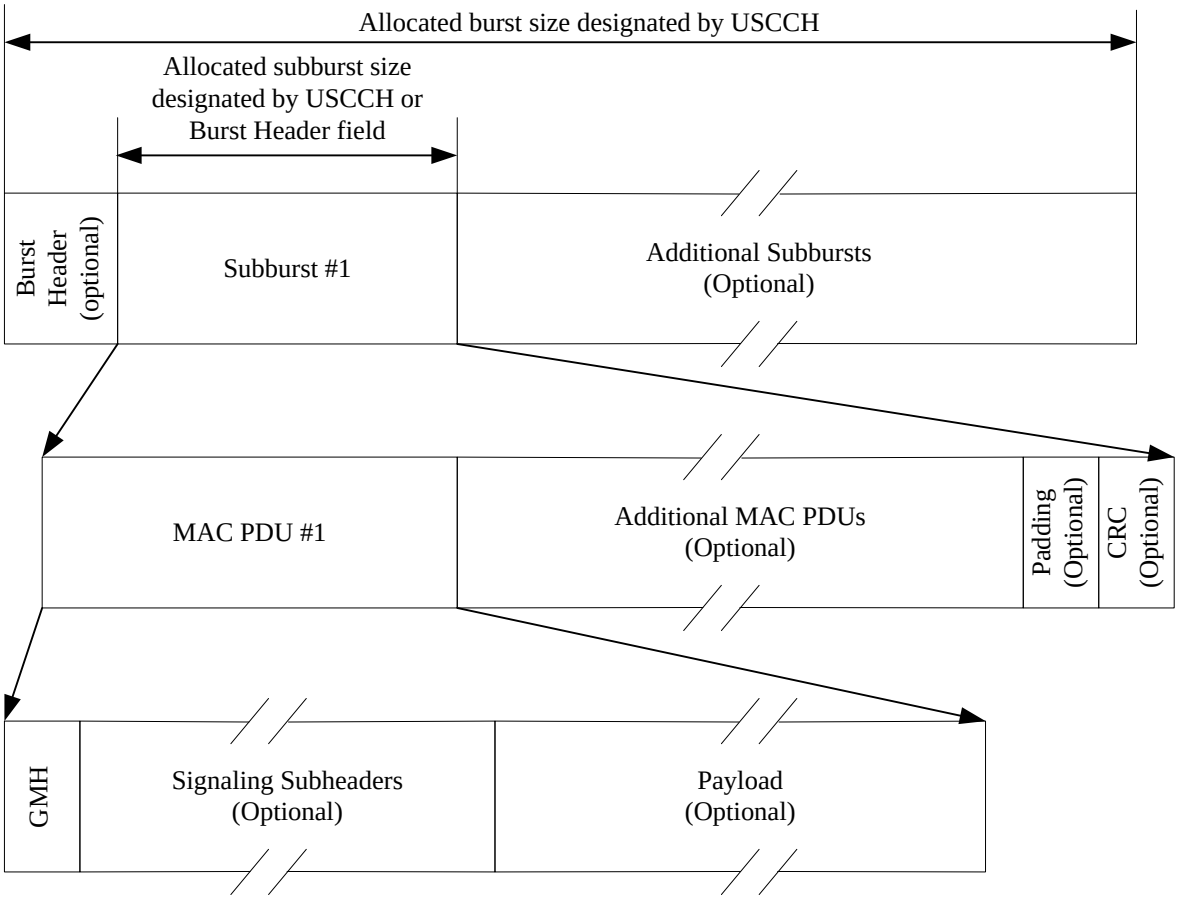

Figure 1 Burst Format

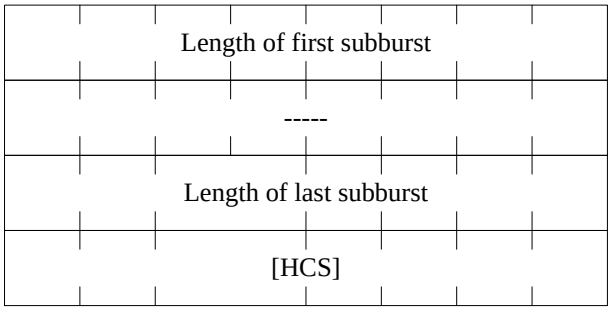

Figure 2 Burst Header Format (optional)

- Length of subburst: This field indicates the length of each subburst. The unit is the size of logical resource unit.
- HCS: Header Check Sequence.

4. Proposed MAC Header Format

Based on the above consideration, we propose Generic MAC header with two types of subheaders: Signaling subheader and Payload subheader.

Generic MAC Header (GMH)

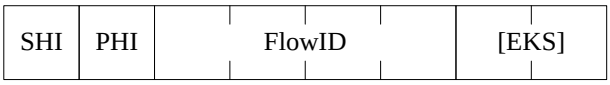

Figure 3 Generic MAC Header Format

- SHI (Signaling Subheader Indicator): When set to '1', this field indicates that one or more signaling subheader (SSH) is present following GMH.
- PHI (Payload Subheader Indicator): When set to '1', this field indicates that one or more payload subheader (PSH) is present following GMH or SSH.
- If both of the SHI and PHI fields are set to '0', it indicates that there is no more MAC PDUs in the subburst. That is, it can be used to indicate the start of padding.
- FlowID (Flow Identifier): This field indicates the flow that is addressed. This field is 4 bits long.
- [EKS]: Encryption Key Sequence.

Signaling Subheader (SSH)

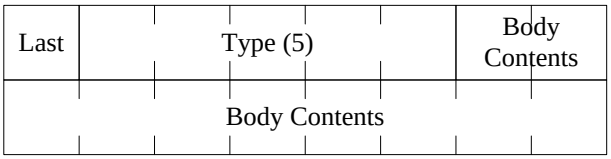

Figure 4 Signaling Subheader Format

- Last: When the "Last" bit is '0', another signaling subheader will follow the current signaling subheader. If this bit is '1', this signaling subheader is the last.
- Type: Type of Signaling subheader (SSH).
- Body Contents: Type-dependent contents.

Payload Subheader (PSH)

Two types of PSH are proposed. One is compact payload subheader (CPSH) which is for the time critical flow whose packet length is relatively short. ARQ and fragmentation should be disabled because of its time critical characteristics and short length. The other is normal payload subheader (NPSH). NPSH can be used any kinds of flows except for the time critical flow.

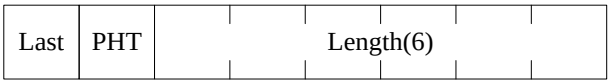

Figure 5 Compact Payload Subheader Format

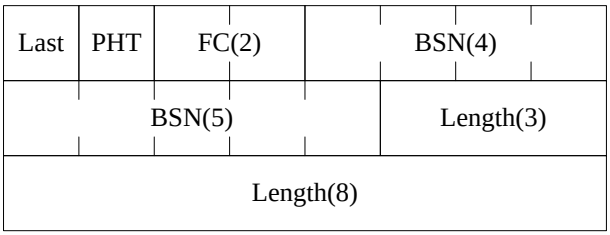

Figure 6 Normal Payload Subheader Format

- Last: When the "Last" bit is '0', another payload subheader will follow the current payload subheader plus payload. If this bit is '1', this payload subheader is the last one.
- PHT: Payload subheader type
  - 0 = Compact Payload subheader
  - 1 = Normal Payload subheader
- FC: Indicates the fragmentation state of the payload
  - 00 = no fragmentation
  - 01 = last fragment
  - 10 = first fragment
  - 11 = continuing (middle) fragment
- BSN: Sequence number of the current ARQ block or the current SDU fragment
- Length: Length of the current payload subheader plus payload in bytes. In case of CPSH, the length of CPCH plus payload becomes the 'Basis Length Value (BLV)' plus the value in the length field where the BLV can be defined using one of following methods:
  - Level 4: The BLV can be set using 'BLV SSH' for each PDU. This BLV is applied to all the CPSHs in the current MAC PDU.
  - Level 3: The BLV can be set at USCCH for each burst. This BLV is applied to all the CPSHs in the burst designated by USCCH.
  - Level 2: The BLV can be set for a service flow. This BLV is applied to all the CPSHs for the service flow.
  - Level 1: The BLV can be set using broadcast channel (BCH) for the entire CPSHs in the system.
  - Level 0: Default value of the BLV is 0.

The priority of applying the BLV setting is from Level 4 to Level 0 from the highest priority to the lowest priority.

5. Example of SSH

The MAC Signaling header types I, II and extended subheaders can be merged to one 802.16m SSH.

Bandwidth Request SSH

Bandwidth request has two types. One is incremental, the other is aggregated. It can be differentiated with subtype field.

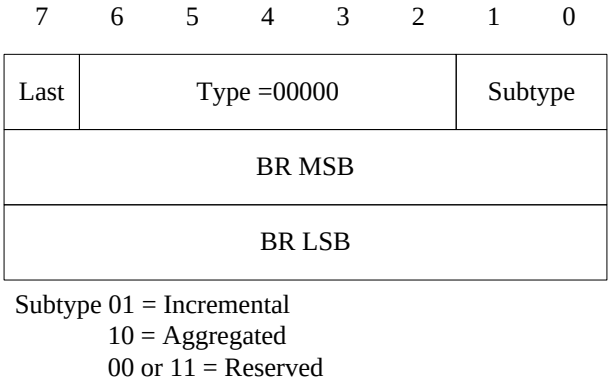

Figure 7 Bandwidth Request SSH

Report SSH

MS can send reports using Report SSH to indicate its status.

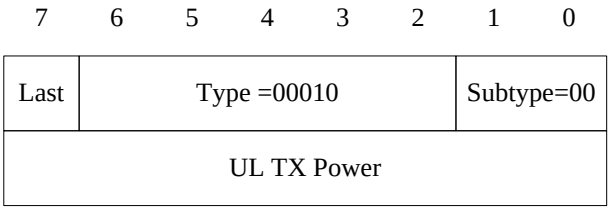

Figure 8 UL Tx Power Report SSH

Other SSH

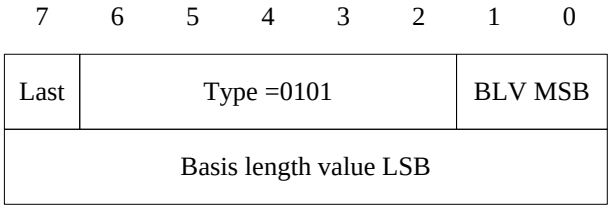

Figure 9 Basis Length Value SSH

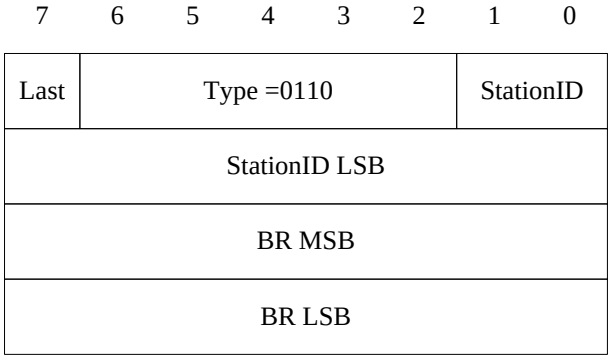

Figure 10 Contention Based BR SSH

6. Example of MAC PDU and Burst

Based on the above consideration, we propose the following MAC PDU format, where SSH or PSH may exist or not. That is, each MAC PDU can contain signaling messages only, payloads only, or both of the signaling message and payloads.

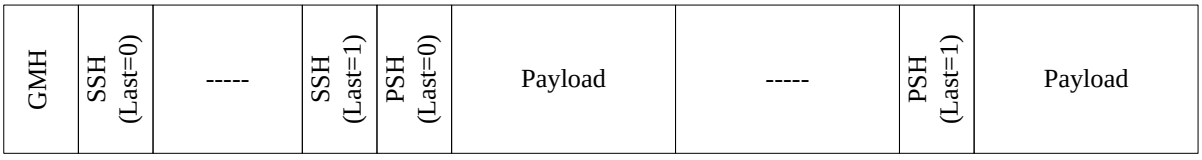

Figure 11 MAC PDU Format

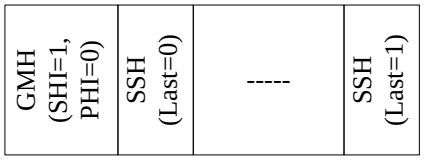

Figure 12 MAC PDU with Signaling Message Only

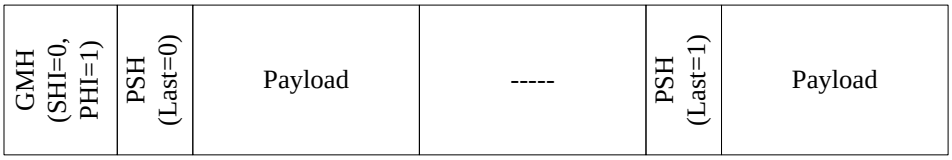

Figure 13 MAC PDU with Payloads Only

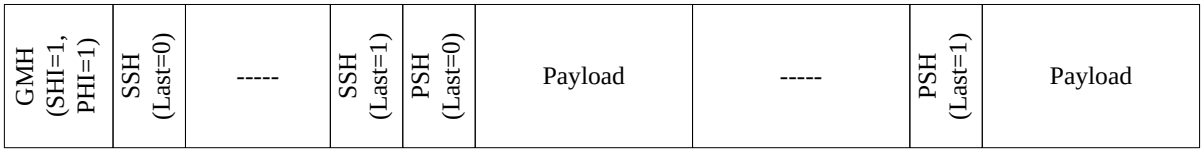

Figure 14 MAC PDU with Signaling Messages and Payloads

Concatenated MAC PDU can be encrypted at the same time to reduce the security overhead. In this case, the first MAC PDU should have the ROC SSH and PDU-SN SSH to indicate that all the MAC PDUs in the subburst are encrypted at the same time. The second and more MAC PDUs do not need the ROC SSH.

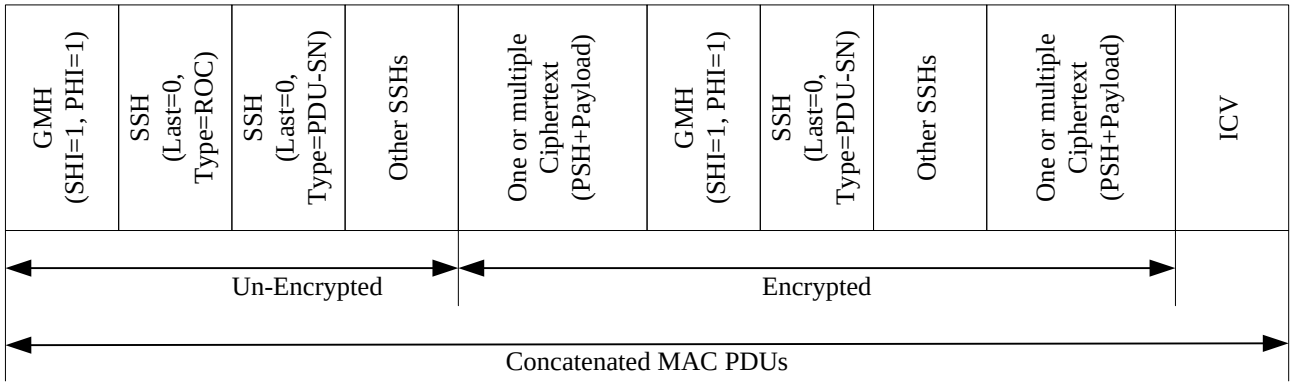

Figure 15 Concatenated MAC PDUs

Following example shows VoIP packet transmission using the proposed burst format. VoIP packet is generated using AMR without header compression in IPv4.

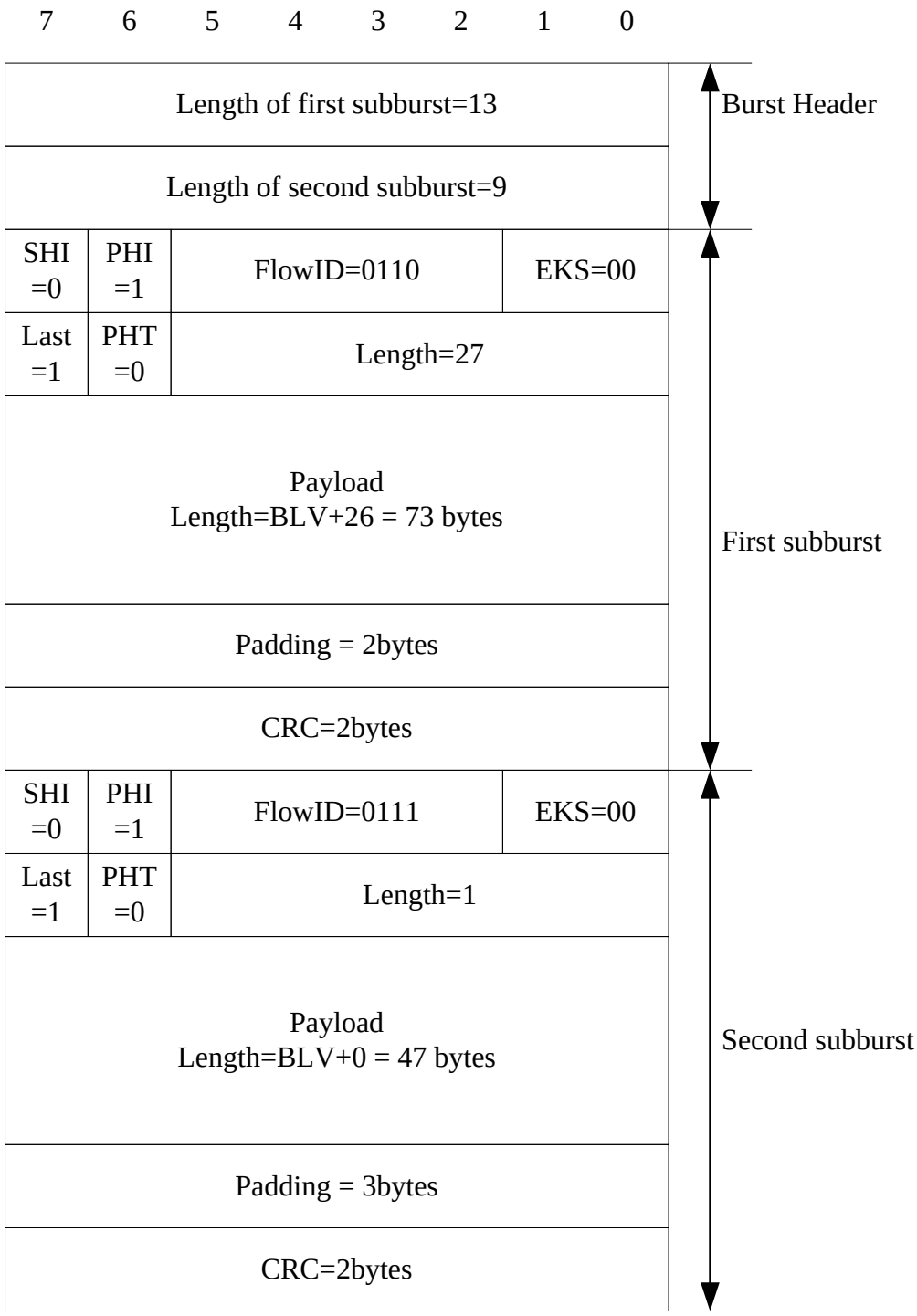

Figure 16 Burst with Burst Header

Text Proposal

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10.12 MAC PDU and Burst Formats

MAC PDU and burst shall be of the form illustrated in Figure XX1.

Each burst may have the optional burst header field followed by the first subburst. More subbursts may follow the first subburst. If present, burst header shall be of the form illustrated in Figure XX2.

Each subburst has one or more MAC PDUs. Padding and CRC are may follow the concatenated MAC PDUs.

Each PDU begins with the generic MAC header (GMH). The header is followed by the signaling subheaders, payload or both of the signaling subheaders and payload. If present, the payload shall consist of one or more Payload subheaders and one or more MAC SDUs and/or fragments thereof.

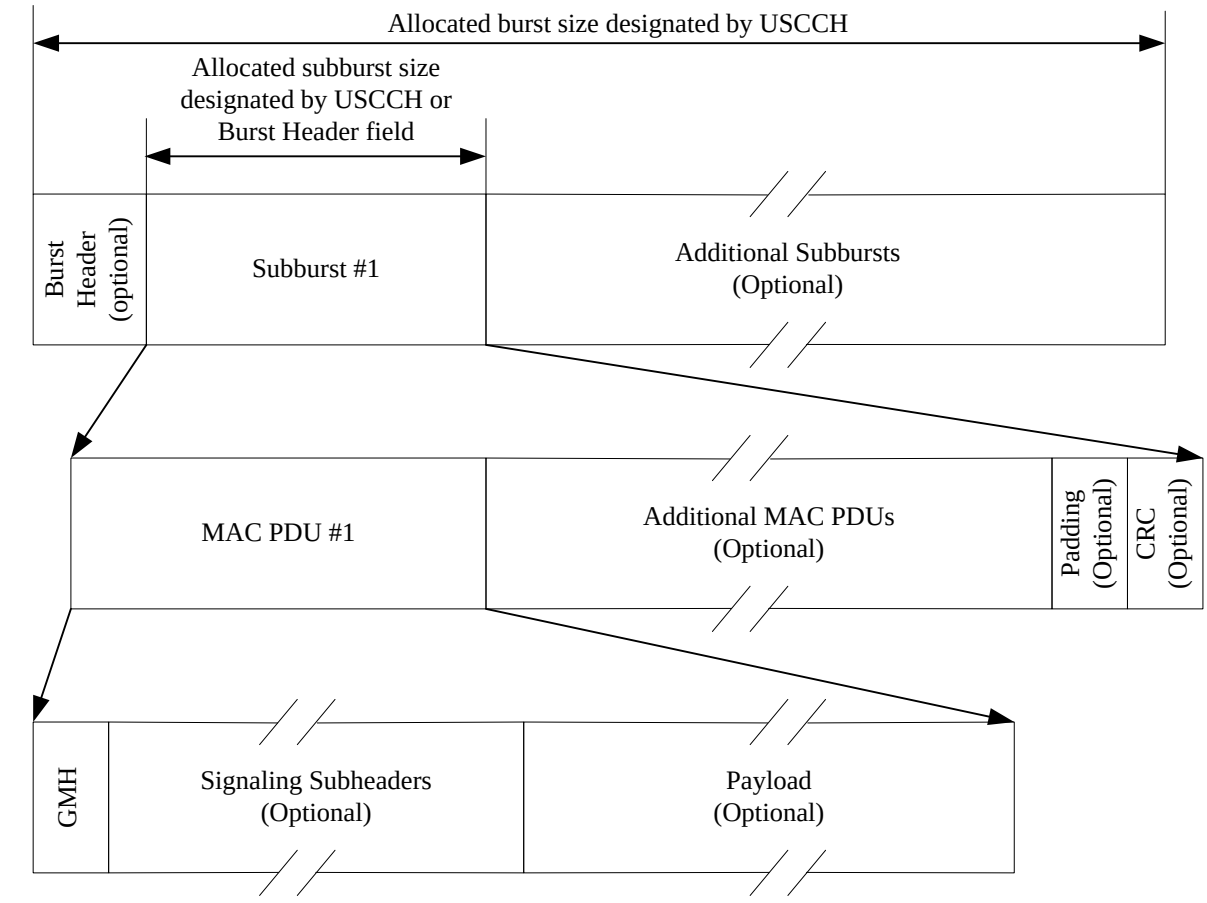

Figure XX1 MAC PDU and Burst Formats

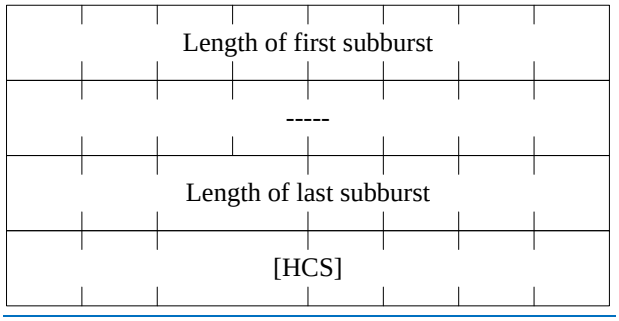

Figure XX2 Burst Header Format

Each MAC PDU contains a MAC header. The MAC PDU may contain payload. ~~The MAC PDU may contain one or more extended headers.~~

~~Multiple MAC SDUs and/or SDU fragments from different unicast flows belonging to the same AMS can be multiplexed into a single MAC PDU~~

10.12.1 MAC header formats

10.12.1.1 Generic MAC Header

[Replace Figure 22 as indicated:]

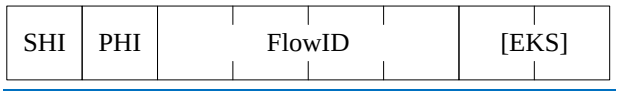

Figure 9 Generic MAC header format

- ~~HT (Header Type): Indicates the type of the header. This field is TBD bits long.~~
- ~~EH (Extended Header Presence Indicator): When set to '1", this field indicates that an Extended Header is present following this GMH.~~
- SHI (Signaling Subheader Indicator): When set to '1', this field indicates that one or more Signaling subheader (SSH) follows the generic MAC header.
- PHI (Payload Subheader Indicator): When set to '1', this field indicates that one or more payload subheader (PSH) follows the generic MAC header or SSH. If both of the SHI and PHI fields are set to '0', this indicates the start of padding.
- FlowID (Flow Identifier): This field indicates the flow that is addressed. This field is 4 bits long.
- [EKS (2bits):] Encryption Key Sequence
- ~~Length: Length of the payload. This field is 11 bits long.~~
- ~~FPI: The inclusion of FPI in GMH is FFS~~

~~10.12.1.2 Compact Header~~

~~Compact header format is FFS.~~

~~10.12.1.3 Multicast/Broadcast MAC header~~

~~10.12.1.4 Multiplexing MAC Header~~

~~10.12.1.5 Signaling MAC Header~~

~~Signaling header format is FFS.~~

10.12.2 ~~Extended header~~ MAC subheader formats

10.12.2.1 Signaling subheader (SSH)

The inclusion of ~~extended header~~ Signaling subheader is indicated by ~~EH indicator~~ Signaling subheader indicator (SHI) bit in MAC Header. The ~~EH~~ SSH format is shown in Figure 10 and will be used unless specified otherwise.

[Replace Figure 23 as indicated:]

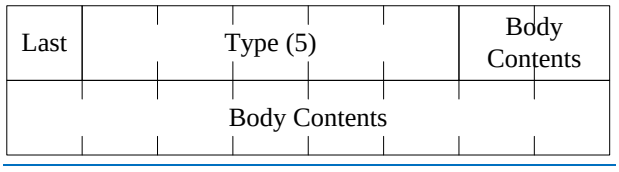

Figure 10 ~~Extended Header~~ Signaling Subheader Format

- Last: When the "Last" bit is ~~set~~ 0, another ~~extended header~~ Signaling subheader will follow the current ~~extended header~~ Signaling subheader. If this bit is ~~not set~~ 1, this ~~extended header~~ Signaling subheader is the last one.
- Type: indicates the type of ~~extended header~~ signaling subheader. The length is ~~TBD~~ 5.
- Body Contents: Type-dependent contents.

~~10.12.2.1 Fragmentation and packing extended header~~

~~Fragmentation and packing extended header format is FFS.~~

10.12.2.2 Payload subheader (PSH)

The inclusion of Payload subheader is indicated by the Payload subheader indicator (PHI) bit in MAC Header. The PSH format has two types. One is Compact type shown in Figure XX3, the other is Normal type described in Figure XX4.

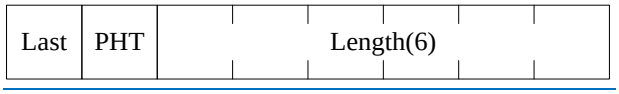

Figure XX3 Compact Payload Subheader (CPSH) Format

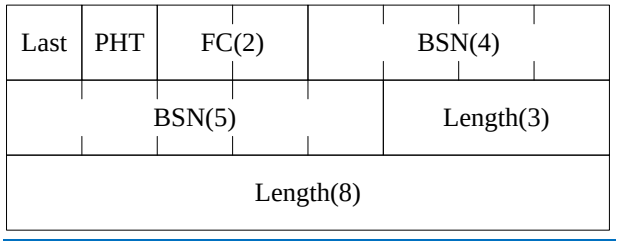

Figure XX4 Normal Payload Subheader (NPSH) Format

- Last: When the "Last" bit is '0', another Payload subheader will follow the current Payload subheader plus payload. If this bit is '1', this Payload subheader is the last one.
- PHT: Payload subheader type
  - 0 = Compact Payload subheader
  - 1 = Normal Payload subheader
- FC: Indicates the fragmentation state of the payload
  - 00 = no fragmentation
  - 01 = last fragment
  - 10 = first fragment
  - 11 = continuing (middle) fragment
- BSN: Sequence number of the current ARQ block or the current SDU fragment
- Length: Length of the current Payload subheader plus payload in bytes. In case of CPSH, the length of CPCH plus payload becomes the 'Basis Length Value (BLV)' plus the value in the length field where the BLV can be defined using one of following methods:
  - Level 4: The BLV can be set using 'BLV SSH' for each PDU. This BLV is applied to all the CPSHs in the current MAC PDU.

- Level 3: The BLV can be set at USCCH for each burst. This BLV is applied to all the CPSHs in the burst designated by USCCH.
- Level 2: The BLV can be set for a service flow when the service flow is created. This BLV is applied to all the CPSHs for the service flow.
- Level 1: The BLV can be set using broadcast channel (BCH) for the entire CPSHs in the system.
- Level 0: Default value of the BLV is 0.

The applying priority of the BLV setting is Level 4, Level 3, Level 2, Level 1 and Level 0 from the highest priority to the lowest priority.

10.12.3 Concatenating MAC PDUs to reduce security overhead

Multiple MAC PDUs which are constructed for different unicast flows belonging to the same AMS may be concatenated and encrypted together to reduce security overhead.

First MAC PDU of the concatenated MAC PDUs shall contain ROC SSH and PDU-SN SSH to give parameters for the security.

The format for concatenated MAC PDUs to reduce security overhead is illustrated in Figure XX4.

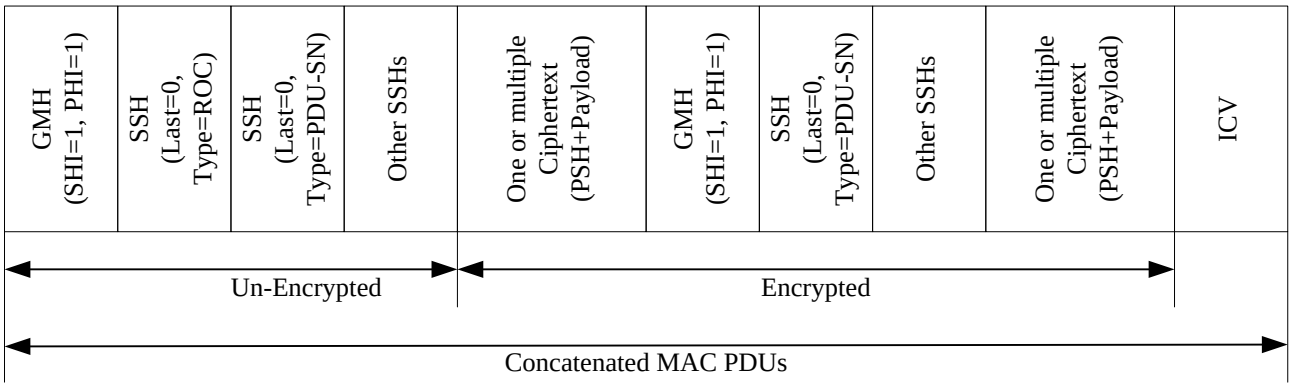

Figure XX5. Concatenated MAC PDUs for Reducing Security Overhead

10.6.5.1.2 ~~Multiplexing MPDUs~~ Concatenating MPDUs to reduce security overhead

When some connections identified by flow ids are mapped to the same SA, their ~~payloads~~ MPDUs can be ~~multiplexed together into one MPDU~~ concatenated . The ~~multiplexed payloads~~ concatenated MPDUs are encrypted together. The first MPDU of the concatenated MPDUs shall contain ROC SSH and PDU-SN SSH to indicate that the concatenated MPDUs are encrypted together. In Figure 11, Flow_x and Flow_y have payload x and y respectively which are mapped to the same SA. ~~The MAC header provides the details of payloads which~~

~~are multiplexed.~~

Note that the multiplexed MPDU format in figure Figure 11 can be changed according to mechanism for single MDPU encryption.

[Replace Figure 20 as indicated:]

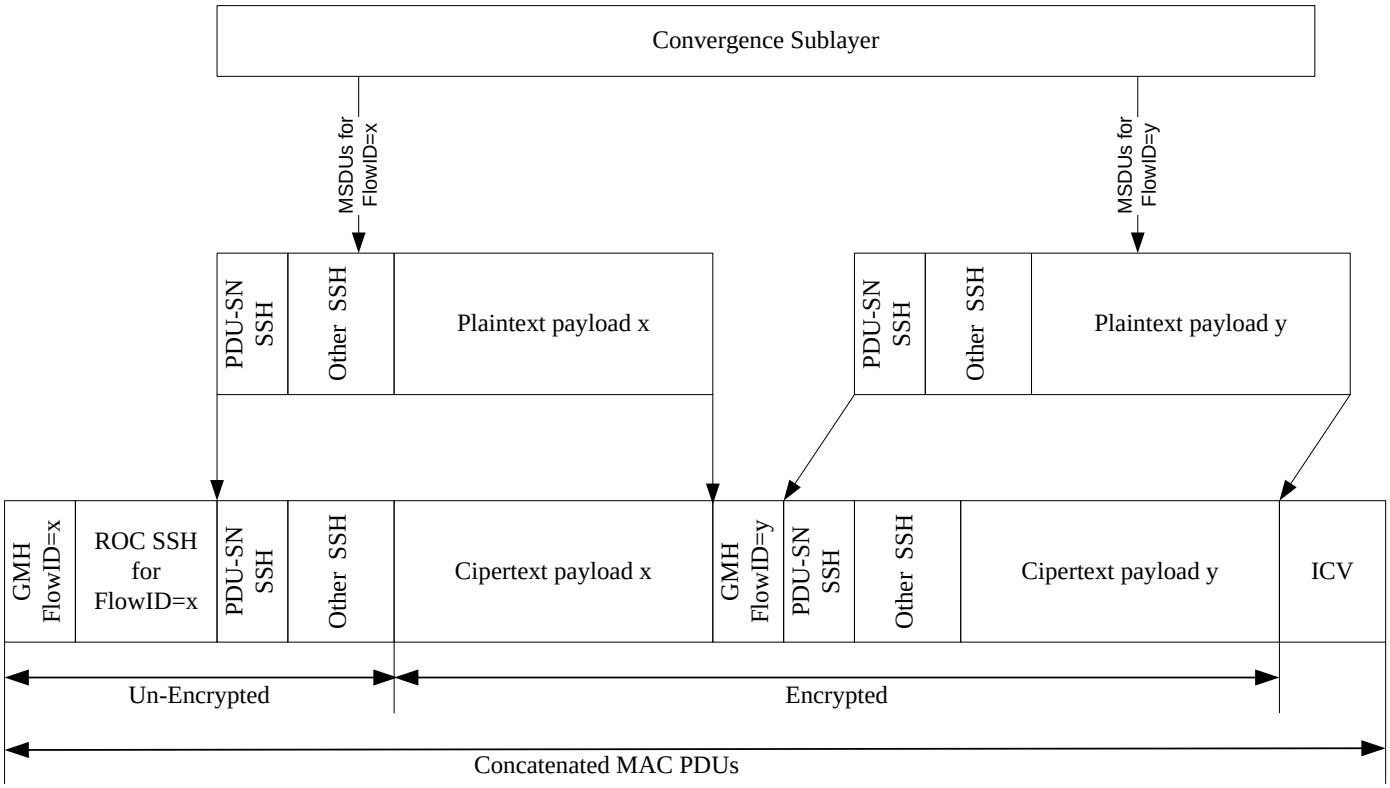

Figure 11 ~~multiplexed~~ Concatenated MAC PDUs ~~format~~ to reduce security overhead

In case of the ~~multiplexed~~ concatenated MPDUs to reduce security overhead, the ~~multiplexed~~ concatenated MPDUs ~~is~~ are encrypted by using ROC and PDU_ SN of the first flow PDU only. Hence the other flow's ROCs are to be omitted, but the ROCs are maintained per flow implicitly. ROC and PDU_ SN of the first flow PDU is not encrypted.

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