Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**MAC Headers Structure for 802.16.4**
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Re:	This document is submitted in response to IEEE 802.16.4-00/01 **Call for Contributions for Modifications of 802.16 MAC and 802.11a - HIPERLAN/2 PHY for the WirelessHUMAN Standard** "
Abstract	This document figures the changes needed in the MAC header format of the TG1 MAC to reach the high flexibility needed for further development in the direction of TG3/TG4
Purpose	The document is submitted as a part of development of 802.16.4 MAC given TG1 MAC as a baseline
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MAC Headers Structure for 802.16.4

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1. References

[1] IEEE 802.16.1/D1 - 2000, December 2000. Draft Standard for Air Interface for Fixed
[2] IEEE 802.16p-00/10. Some Issues of Accommodation of TG1 MAC at TG3. By Vladimir Yanover
[3] IEEE 802.16.3p-00/56.Using the TG1 MAC for the TG3 Purposes. V.Yanover, S.Varma, H.Ye
[4] IEEE 802.16.3-01/XX. Reservation Tools for the 802.16.4 MAC. Naftali Chayat, Vladimir Yanover
[5] IEEE 802.16.3-01/XX. Data Integrity in 802.16.4 MAC Naftali Chayat, Vladimir Yanover, Inbar Anson

2. Problems

Today we are not certain now about the functions we want to cover by the MAC Header fields. This concerns mainly TG3 and TG4: concatenation of the payloads, ARQ, advanced QoS signaling, PHY related signaling, etc. But for the long run it is correct also for TG1 (note the massive changes entering now the 802.11, a year after the release of the 1999 version).

So we need to reserve a space for making detailed decisions later.

3. Possible Solution

The decision proposed is to employ more flexible MAC header format. "Flexible" means that different types of messages may differ in length and the set of fields included.

It is suggested to keep the first portion of the MAC header of the fixed format so that the PHY Convergence (former Transmission Convergence) layer operations would be easier for HW implementation. This portion is protected by HCS.

All the rest of fields are placed after the HCS and form actually a single body with the MAC payload. Actually this was already done in the recent draft with the ARQ Control Field.

All the other fields are divided into a small number of groups (e.g. EC+ EKS+ FC + FSN + CSI + PDE relevant only to Data messages) and make the presence of the whole group dependent on the Type value.

4. General MAC Message Format

The following is the general MAC message format. The MAC Header contains the following zones:

Type, Length, CID, HCS	**Data Control**	**CS PDU Identification**	**GM**	**AFB (ARQ Feedback)**
Constant part, obligatory	Optional, contains EC, EKS, FSN and similar	Optional Contains CS PDU Serial Number and Retry Number	Optional, like in the existing draft, but with request field enlarged to 16 bits	Optional, Contains ARQ Feedback records

Possible ARQ Feedback Zone Structure. It is assumed that the record contains Last bit: 1 means the last AFB record.

AFB Record #1	AFB Record #2		AFB Record #n (last)

The field includes CID occupies an integer number of bytes (See the details in [5])

5. MAC Message Types

The following is a list of possible types

- Data DL (with the option of piggybacked ACK info)
- Data UL (with the option of piggybacked BWR and ACK info)
- BW Request
- ACK
- Management

Each of these types has certain set of fields.

The following is the rule for the zones may be present independently

- For DL Data
  - CS PDU ID
  - AFB
- For UL Data
  - CS PDU ID
  - AFB
  - GM
- For BWR/ACK message
  - GM
  - AFB

Therefore this scheme needs total 17 type values including Management (of total 32 possible). The rest of them are reserved.

6. Examples

This paragraph figures several possible formats of UL Data message and BWR. In these examples GM field is enlarged to 16 bits (that is a separated issue).

In these examples the constant format portion (obligatory) is marked green, data control portion - brown, ARQ specific portion — blue, Grant Management — yellow, ARQ feedback — magenta. The presence of each portion is defined by the Type field and / or the fact that ARQ is enabled/disabled for the given connection.

6.1. UL Data Message

Example #1
Type = Data + ARQ Disabled + piggybacked GM present + No piggybacked ARQ feedback

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type					Length										
CID															
HCS								CSI	CI	FC		FSN			
EC	EKS			PDE	Reserved			GM							
GM — cont								CS PDU Data							
CS PDU Data															
CRC															
CRC-cont															

Note that the UL Data message header with encryption control + fragmentation control would be of 8 bytes long instead of 9 in [1] — because of the enlarged GM. So actually there is actually no or little difference between this case and existing header format.
This format might be defined obligatory, others optional etc.

Note also that the GM may not be present in all the UL messages and then we have header of only 7 bytes.

Example #2
Type = Data + ARQ Enabled + piggybacked GM present + piggybacked ARQ feedback present

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type					Length										
CID															
HCS								CSI	CI	FC		FSN			
EC	EKS			PDE	Reserved			Retry Number				Sequence Number			
Sequence Number — cont.								GM							
GM - cont								ARQ Feedback							
ARQ Feedback-cont															
ARQ Feedback-cont															
CS PDU Data															
CRC															

CRC-cont

Example #3
Type = Data + piggybacked GM present

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type					Length										
CID															
HCS								CSI	CI	FC		FSN			
EC	EKS		PDE	Reserved				GM							
GM — cont								CS PDU Data							
CS PDU Data															
CRC															
CRC-cont															

Example #3
Type = Management message

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type					Length										
CID															
HCS								Management message data							
Management message data															
CRC															
CRC-cont															

6.2. BW Request Message

Example #4
Type = BW Request + piggybacked ARQ Feedback

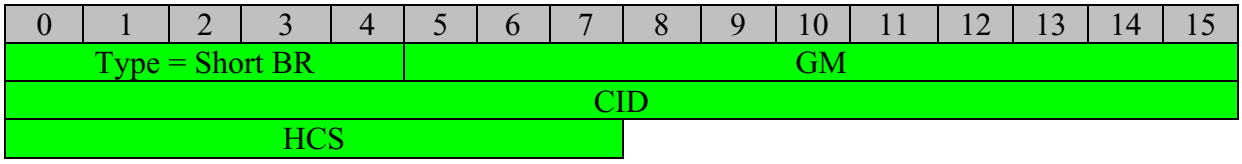
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type					Length										
CID															
HCS								GM							
GM — cont								ARQ Feedback							
ARQ Feedback-cont															
ARQ Feedback-cont															
CRC															
CRC-cont															

The same fields as in [1] are present and the size of the correspondent part is 7 bytes but CRC is needed additionally thus resulting in 11 bytes (compare this to 7 bytes in [1]). Note that this

format allows for adding ARQ feedback records. To decrease the overhead a shortened format may be proposed:

Example #5

Type = Shortened BW Request



Note that this message requires only 5 bytes, but in the price of replacing Length with GM that makes an exception in encoding of the first header portion.