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| Title | **Proposed MAC Layer Overhead Reduction Schemes** | |
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| Source(s) | Menashe Shahar Full Spectrum Inc. 687 N. Pastoria Ave. Sunnyvale, CA. 94085. USA | Voice: (650) 814-7377  E-mail: mshahar@fullspectrumnet.com |
| Re: | Call for Contributions: IEEE 802.16 Working Group on Broadband Wireless Access GRIDMAN Task Group: Project 802.16s  IEEE 802.16-16-0035-03-000s | |
| Abstract | Describes Full Spectrum’s proposed MAC Layer Overhead Reduction Schemes for IEEE802.16s. | |
| Purpose | For consideration during Working Group Session #106 | |
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# Proposed MAC Layer Overhead Reduction Schemes for

# IEEE 802.16s

October 27, 2016

# General

1. Ieee802.16s is designed for channel bandwidth between 100 KHz and 1.25 MHz. As the channel size is reduced, the standard ieee802.16s MAC layer overhead increases. The goal of the proposed MAC layer amendments described in this proposal is to cap the MAC layer overhead below 10%.
2. This document describes the proposed MAC layer overhead reduction schemes for IEEE802.16s.The focus is on the reduction of per-frame overhead while additional overhead components (PDU header overhead and the overhead related to MAC messages) which are not transmitted every frame will be addresses in subsequent proposals.
3. An excel spreadsheet calculator is provided to support this proposal as a separate contribution DCN 16-16-0060-00-000s

# Proposed Overhead Reduction Schemes

# DL/UL MAP GMAC header and CRC structure

1. The standard GMAC header size is 6 bytes. It is proposed to reduce the GMAC header size to 2 bytes by dropping all the well-known or fixed value fields and unused fields.

1. Fields HT, EC, Type, ESF, CI, EKS, Rsv and CID are dropped for the following reasons:

* HT - header type always zero
* EC - always non encrypted
* Type - indicates sub-header and special payload types. Not used
* ESF - DL-MAP never uses extended sub-header.
* CI - CRC always present. Known information
* EKS - always non encrypted.
* Rsv – reserved
* CID - always broadcast CID

1. The standard GMAC header is shown below. The number in bracket indicates the respective field size in bits. This structure is used ion the standard for both the DL and UL MAPs.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| HT (1) | EC(1) | Type (6) | ESF(1) | CI(1) | EKS(2) | Rsv(1) | LEN MSB(3) |
| LEN LSB (8) | | | CID MSB (8) | | | | |
| CID LSB (8) | | | HCS (8) | | | | |

1. **Modified DLMAP GMAC header structure**: the DLMAP is always the first burst in the DLSF so it can be identified as DLMAP directly. CID indication is therefore not needed at the receiver side .The modified GMAC header consists of 1 byte length field and 1 byte for HCS field.

Modified DLMAP GMAC header:

|  |  |
| --- | --- |
| LEN (8) | HCS (8) |

1. **Modified ULMAP GMAC header structure:**

* 1. The ULMAP, if present, is the first data burst in the DLSF after DL-MAP, but it may not always be present in a frame in which case, the first burst may carry data traffic. To avoid conflict, we propose to use the first bit HT = 1 as the key to identify the burst as ULMAP.
  2. The modified UL MAP has reserved 7 bits for ULMAP length indication as it cannot exceed 128 bytes.

Modified ULMAP GMAC header:

|  |  |  |
| --- | --- | --- |
| HT (1) | LEN (7) | HCS(8) |

1. **CRC****:** The standard specifies 32 bit CRC for the PDU. The modified DL/UL MAP has 8 bit CRC. This is justified because the modified MAPs length is drastically reduced. Based on the length field the DLMAP does not exceed 256 bytes and the ULMAP field does not exceed 128 bytes. An 8 bit CRC is sufficient to protect such a short PDU size.

# CID switch IE

1. This IE Indicates whether DL-MAP includes CID information or not. We propose to drop this IE and to always drop the CID information in the modified MAP. This can be done since the CID is also included in the data PDU header. This contributes to 12 bits savings.

# Modified DL MAP IE structure

1. Rectangular burst geometry is replaced by slots allocation, similar to the ULMAP burst structure. Rectangular fitting of DL bursts is replaced with linear filling of DL bursts. The number of slots per downlink burst is transmitted in the DL MAP IE. Slots allocation per burst is continuous by traversing first in frequency and then in time for a given frame configuration. With linear DLMAP structure, the first slot of the next burst is identified by the last slot of the previous burst. The number of slots per burst is sufficient to define the architecture of the burst.
2. CID information is removed in the modified DLMAP. This implies the remote station PHY layer has to decode all downlink bursts. Filtering of the downlink PDUs of interest to a specific remote is done by the MAC layer based on the CID in the data PDU GMAC header.
3. The information per DL MAP IE includes:
   1. DIUC – 4 bits (this field is retained from the standard)
   2. Number of slots per burst – 8 bits (this filed is added).

1. The following fields in the standard DL MAP IE are dropped:
   * N\_CID - The number of CIDs in the burst. This is dropped because the CIDs are not transmitted in the DLMAP.
   * CIDs - This is dropped because the CIDs are not transmitted in the DLMAP.
   * Symbol Offset - This is dropped due to DL MAP IE geometry change
   * Sub-channel Offset - This is dropped due to DL MAP IE geometry change
   * No of Symbols - This is dropped due to DL MAP IE geometry change
   * No of Sub-channels - This is dropped due to DL MAP IE geometry change
   * Boosting – It is proposed to avoid per burst boosting.
   * Repetition - This is dropped because an unused DIUC value is employed to identify QPSK1/2 with repetition 2. Due to the high overhead, repetition 4 and 6 should not be used in narrow channels.

# Modified UL MAP IE structure

1. **IR/HR & PR/BR IEs**

Initial Ranging/Handover Ranging (IR/HR) and Periodic Ranging/Bandwidth Request (PR/BR**)** IEsare used to identify the regions in the ULSF allocated for IR/HR and PR/BR CDMA code transmission.

For 128 FFT, IR/HR and PR/BR extends over a full channel.

The following rules are proposed for the construction of IR and PR IEs:

* IR/HR and PR/BR allocations extend over a fixed number of OFDMA symbols (e.g., 3 symbols @ 1 MHz wide channel).
* IR/HR and PR/BR are not allocated at the same frame.
* IR/HR and PR/BR are always allocated as the first burst in the ULSF.
* IR/HR is identified by UIUC = 12. PR/BR is identified by UIUC = 10.

With the above rules, the need to identify the geometry of IR/HR and PR/BR bursts is avoided.

Fields retained in the IR/PR IE:

* UIUC - 4 bits

The following fields are dropped:

* OFDMA Symbol Offset - Transmission of geometry information not needed
* Sub-channel Offset - Transmission of geometry information not needed
* No of Symbols - Transmission of geometry information not needed
* No of Sub-channels - Transmission of geometry information not needed
* Ranging Method – 0b00 Indicates 2 symbol initial/handover ranging 0b10 Indicates 1 symbol periodic/BR ranging. This is indicated by separate UIUC so dropped
* Ranging Indicator - 0b0 Indicates normal ranging 0b1 Indicates dedicated ranging. This is dropped as we propose to always do normal ranging
* CID – IR and PR bursts are always transmitted using broadcast CID.

1. **DATA Burst IE (UIUC = 1 to 8)**

UL data burst geometry is defined by the “duration” field which contains the number of slots in the burst. Slots allocation per burst is continuous by traversing first in time and then in frequency for a given frame configuration. We propose to drop the repetition field and a new UIUC value for QPSK ½ with repetition 2.

The modified data burst IE includes:

* CID – 16 bits
* UIUC – 4 bits
* Duration – 10 bits

1. **CDMA-ALLOC IE (UIUC = 14)**

CDMA-ALLOC IE identifies the region in the ULSF in which a remote station should transmit a ranging message.

Modified CDMA- ALLOC IE fields:

* UIUC- 4 bits
* Duration – 4 bits (Usually 9 slots allocation so 4 bits are sufficient).
* Frame Number Index- 4 bits. Indicates the frame number in which the CDMA code to which this message responds was transmitted.
* Ranging Code – 8 bits. Indicates ranging code sent by the remote.
* BW request mandatory - Indicates whether the remote shall include a BR in the allocation.

Fields dropped:

* Ranging Symbol - Well known, can be dropped.
* Ranging sub channel - Well known, can be dropped.

1. **Power Control IE** (UIUC = 9)

The standard power control IE which is carried in extended UIUC is replaced with un-used UIUC value 9.

Fields used in the modified power control IE:

* CID – 8 bits
* UIUC – 4 bits
* Power control – 8 bits (change in power level).

Fields dropped:

* Extended UIUC
* Length
* Power Measurement Frame

# MAC Management Message (MMM) Structure

1. **DL MAP MMM Structure Modifications:**

Fields used:

* Frame number: this field is retained from the standard DL MAP MMM but its length is reduced from 24 bites to 16 bits.

Fields dropped:

* Management Message Type = 2

DLMAP is always the 2nd burst (after FCH) in the DLSF and it is carried in every frame. As such, it can be identified without the presence of the type field which therefore can be dropped.

* Frame Duration Code

This field conveys frame duration with which BS is transmitting. For the given deployment, this is well known information so need not be transmitted every frame and hence dropped

* DCD Count

We propose to maintain DIUC to burst profile/FEC code mapping static per deployment and as such, this parameter can be dropped.

* Base Station ID

This information does not need to be carried in DL-MAP every frame. Instead BS can send this information as an additional parameter in registration response. This way this information is exchanges only during network entry which should be sufficient.

* Number Of OFDMA symbols

This filed carrier information about total number of symbols in DL SF

This information changes based on deployment and it is fixed for a given deployment. So it can be statically configured at the remote

1. **UL MAP MMM Structure Modifications:**

Fields used: None

Fields dropped

* Management Message Type = 3

ULMAP is always the 3rd  burst (after FCH and DLMAP) in the DLSF and it is carried in every frame. As such, it can be identified without the presence of the type field which therefore can be dropped.

* FDD Partition flag

This is FDD specific flag hence dropped as system is TDD

* Reserved (7 bits) – not used
* UCD Count

We propose to maintain UIUC to burst profile/FEC code mapping static per deployment and as such, this parameter can be dropped.

* Allocation Start Time

UL allocation start time is relative to start of frame. This is well-known at the remote and can be dropped.

* Number Of OFDMA symbols

This field carries information about total number of symbols in ULSF. This information changes based on deployment and it is fixed for a given deployment. So it can be statically configured at the remote.