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Title	Hierarchical MAP Structure
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Re:	IEEE P802.16e/D5-2004
Abstract	This contribution proposes to enhance the DL/UL MAPs to improve power efficiency for MSS in Sleep mode and Idle mode, and also to reduce overhead. This is a revised contribution. Changes are highlighted in blue.
Purpose	Review and Adopt the suggested changes into P802.16e/D5
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1 Introduction

The current DL/UL-MAP design has the following issues:

- In the current design, a MSS in either normal mode, sleep mode – listening interval or Idle mode – paging interval have to demodulate and decode all the DL and UL MAPs, even though many of the information contained in the MAPs is not designated to that MSS. The DL and UL MAPs may be long and span multiple OFDMA symbols, thus is not power efficient for as MSS in Idle mode and Sleep mode.
- There is no explicit indication of whether an IE with broadcast CID is designated to all MSS or MSS in certain mode of operation (Normal, Sleep or Idle).
    - When a MSS is in Sleep mode – listening interval, or Idle Mode – paging interval, the MSS needs to decode the DL MAP in order to receive unicast traffic (for sleep mode) or relevant broadcast traffic. However, when the MSS receives an IE with broadcast CID, the MSS has to demodulate and decode the DL OFDMA region assigned by this IE, even though the DL broadcast traffic carried in that OFDMA region is not designated to the MSS which operates in certain mode. This is not power efficient for MSS in Sleep and Idle Modes since the MSS has to demodulate and decode all DL broadcast traffic or messages.
- The current DL and UL IEs are encapsulated in separate DL and UL MAPs. For the case of unicast burst assignment to the same MSS on both DL and UL, the 16-bit basic connection identifier (basic CID) of that MSS will appear twice, one in the DL-MAP and the other in the UL-MAP. This causes unnecessary overhead.
- There is no more room to define new IEs since all the DIUC and UIUC and their extension have been occupied.

2 Proposed Enhancement

We propose the following solutions to address the above-mentioned issues. Since 802.16e system has to be able to support legacy 802.16d MSS, our proposed solution does not impact the operation of 802.16d MSS and should be transparent to the 802.16d MSS.

Hierarchical MAP Structure

We propose a hierarchical MAP structure as shown in Figure 1. We use the first DL-MAP following the FCH as the Root MAP. Since this Root MAP is processed by all MSSs who intend to listen to DL traffic or messages including SS, MSS in Normal mode, MSS in Sleep mode – listening window, and MSS in Idle mode – Paging interval, this Root MAP contains IEs that points to additional DL and UL MAPs, where each of these additional MAPs only needs to be processed by a specific group of MSS, e.g. 802.16d SS, or 802.16e MSS in Normal mode, or 802.16e MSS in Sleep mode – listening window, or 802.16e in Idle mode – paging interval.

Our proposed solution does not restrict how the different additional MAPs are being partitioned as it can be up to individual implementation. However, we propose to introduce a new IE, MSS_region_IE that indicates whether the additional MAP is processed by certain group of MSS.

One example of how the MAPs can be partitioned is illustrated below and in Figure 1 (note that the regions shown in the figure are logical region rather than actual physical subchannel and OFDMA symbol space). In this example, the Root MAP includes the following:

- IEs to point to additional DL/UL-MAPs which only need to be processed by specific groups of MSSs. The additional MAPs include:
    1. MAP for UL common access (i.e. ranging) for all 802.16d SS and 802.16e MSS. This MAP is processed by all 802.16d SS and 802.16e MSS that intends to perform UL access;
    2. Unicast DL/UL MAP for all 802.16d SS. This MAP is processed by all power-on and registered 802.16d SS. This MAP is skipped by all 802.16e MSS (using the new Skip_IE).
    3. Unicast DL/UL MAP for all 802.16e MSS in Normal mode and Sleep mode – listening interval. This MAP is processed by all 802.16e MSS in Normal mode or Sleep mode – listening interval.

  In this way, a particular type of MSS only needs to process the corresponding MAP IEs instead of having to process all the MAP

IEs.

- IEs to point to OFDMA regions for DL broadcast messages. The broadcast regions can be divided into four types:
    1. region containing common broadcast messages for all 802.16d SS and 802.16e MSS, e.g. system parameter broadcast (UCD, DCD) messages;
    2. region containing broadcast messages for all 802.16e MSS, e.g. neighbor BS information advertisement (MOB-NBR-ADV) message;
    3. region containing broadcast messages for all Sleep mode MSS, e.g. traffic indication (MOB-TRF-IND) message;
    4. region containing broadcast messages for all Idle mode MSS, e.g. paging advertisement (MOB-PAG-ADV) message.

  In this way, an MSS operating in certain mode only needs to process the corresponding region and messages instead of having to process all broadcast regions and messages.

- IEs to point to regions for multicast-broadcast service (MBS) traffic. A particular MBS region is demodulated and decoded by MSS that are subscribed to the associated MBS.

- IEs that are addressed to both 802.16d SS and 802.16e MSS, e.g. MIMO_DL_Basic_IE etc.

Specific Standard Changes

The specific changes to the standards text are summarized below:

- In the Root MAP, to point to DL/UL MAP and broadcast message regions specifically for different groups of MSS, we introduce a new IE called the MSS_region_IE. This IE contains an Applicability Code field to indicate what type of region is assigned by the IE. The MSS_region_IE is also used to point to the region for the EN-MAP message (see next bullet).
- We define a new MAP message, called the Enhanced MAP (EN-MAP) message that contains unicast IEs for all 802.16e MSS in Normal mode or Sleep mode – listening interval. The characteristics of the EN-MAP message is as follows:
    - No generic MAC header when this EN-MAP message is transmitted
    - An EN-MAP message contains one or more EN-MAP_IE.
    - Each EN-MAP_IE contains an IE type field of 6 bits. This allows a larger number of types of IEs that can be supported by the EN-MAP message.
    - For each unicast resource allocation, the DL/UL resource allocations are combined together into the same IE whenever possible to reduce MAC overhead, i.e. when the same basic CID for both DL and UL is used for the DL/UL resource allocation.
- In the Root MAP, to allow 802.16e MSS to avoid processing regions designated for 802.16d SS, we introduce a new IE called the Skip_IE. The Skip_IE is used to toggle the enabling and disabling of processing of regions designated by IEs following the Skip_IE. Here is an illustration. The 802.16e MSS sequentially processes IEs and if applicable the associated regions designated by the IEs in the Root MAP. When the first Skip_IE is encountered, the MSS does not process the region designated by IEs following the Skip_IE. When a second Skip_IE is encountered, the MSS revert back to processing the region designated by the IEs following the Skip_IE when applicable. When the next Skip_IE is encountered, the MSS again disables processing of regions designated by subsequent IEs. This procedure continues until the end of the Root MAP.

With the above proposal, both backward compatibility with 802.16d SS, and power saving and overhead reduction for 802.16e MSS can be achieved:

- For an 802.16d SS, the operation is as usual since the 802.16d SSs ignore all newly introduced IEs
- For an 802.16e MSS, unicast information designated for 802.16d SS are skipped for power saving purpose. Also, 802.16e MSS is certain mode (normal, sleep, idle) only needs to process the relevant regions designated for the MSS.

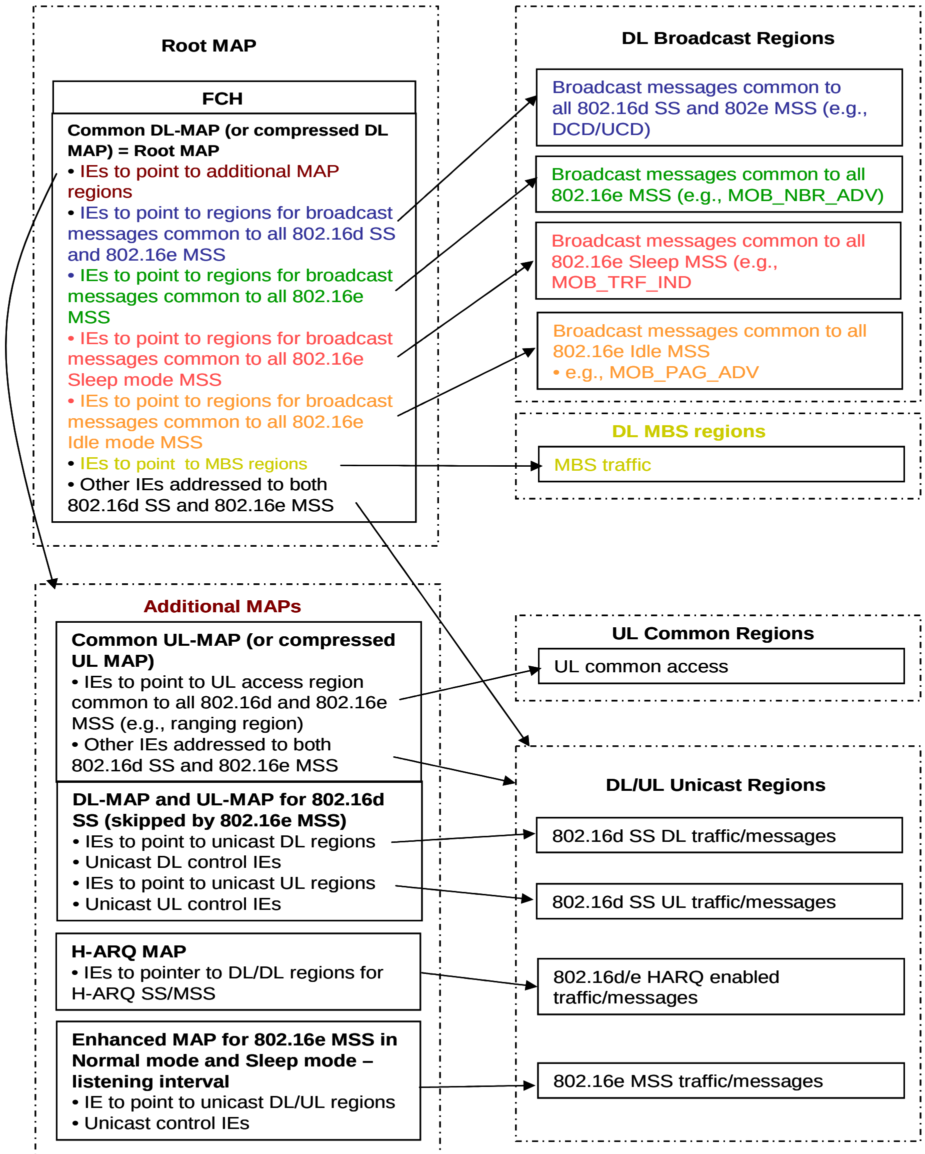

Figure 1. Hierarchical MAP structure

3 Proposed Text Change

Remedy 1:
We introduce a new IE called the MSS_region_IE. This IE allocates DL burst regions and contains an Applicability Code field to indicate what type of region is assigned by the IE.

[Add the follow Section 8.4.5.3.5.20]

8.4.5.3.5.20 MSS Region IE

This IE is sent by BS in DL-MAP/Compressed DL-MAP message as a broadcast type IE. The region indicated by this IE shall be processed by specific group of MSSes indicated in the 'Applicability code' field. There can be more than one MSS Region IEs included in the DL-MAP/Compressed DL-MAP to allocate multiple regions of the same or different types.

Table 298j MSS_ Region_IE Format

Syntax	Size	Notes
MSS_region_IE() {		
Extended DIUC	4 bits	S=0x0B
Length	4 bits	
DIUC	4 bits	
Applicability code	2 bits	0b00: system access and configuration types of messages (e.g., MOB_NBR_ADV). Processed by all 802.16e MSSes 0b01: Enhanced MAP (EN-MAP) message. Processed by 802.16e MSSes in normal and sleep mode – listening window 0b10: Sleep mode specific messages (e.g., MOB_TRF_IND). Processed by 802.16e MSSes in sleep mode – listening window. 0b11: Idle mode specific messages (e.g., MOB_PAG_ADV). Processed by 802.16e MSSes in Idle mode – paging interval.
OFDMA symbol offset	8 bits	
Subchannel offset	6 bits	
Boosting	3 bits	
No. OFDMA symbols	8 bits	
No. Subchannels	8 bits	
Repetition Coding Indication	2 bits	
Padding bits	variable	To align byte boundary
}		

Applicability code

0b00: system access and configuration types of messages (e.g., MOB_NBR_ADV). Processed by all 802.16e MSSes
0b01: Enhanced MAP (EN-MAP) message. Processed by 802.16e MSSes in normal and sleep mode – listening window

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0b10: Sleep mode specific messages (e.g., MOB_TRF_IND). Processed by 802.16e MSSes in sleep mode – listening window
0b11: Idle mode specific messages (e.g., MOB_PAG_ADV). Processed by 802.16e MSSes in Idle mode – paging interval.

Remedy 2:
We define a new MAP message, called the Enhanced MAP (EN-MAP) message that contains unicast IEs for all 802.16e MSS in Normal mode or Sleep mode – listening interval. We define EN-MAP_IEs that are encapsulated in the EN-MAP message.

[Add the follow Section 6.3.2.3.59]

6.3.2.3.59 Enhanced MAP (EN-MAP) message

This EN-MAP message defines the access to the downlink information for OFDMA PHY systems. This message is transmitted without a generic MAC header. This message is transmitted at the DL region indicated by the MSS_Region_IE (Section 8.4.5.3.5.20), with Applicability code set to 01, in the DL-MAP message that presents in the same frame. There can be more than one EN-MAP messages in one frame, as indicated by multiple MSS_Region_IEs with Applicability codes set to 01.

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Table 107c Enhanced MAP message format

Syntax	Size	Notes
Enhanced-MAP_Message_Format () {		
Length	11 bits	The length in bytes of this message.
Slot offset	11 bits	The slot offset relative to the start of the frame, from which the UL burst allocation begins in this message.
Num_IEs	7 bits	Number of Ies in this message
For (I = 0;i++;I < Num_iEs)		
{		
EN-MAP_IE()	variable	See 8.4.5.8
}		
Padding bits	Variable	Ensure to align to the boundary of byte
}		

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Length
Indicate the length of this message in bytes.
Num_iEs
Number of iEs in this message.

[Add the follow Section 8.4.5.8]

8.4.5.8 EN-MAP IE

An EN-MAP IE defines the access to the OFDMA downlink information, allocates access to the UL channel, or is a control IE to request MSSes to take certain actions. The IE format is defined in Table 303b

Table 303b EN-MAP_IE Format

Syntax	Size	Notes
EN-MAP_IE() {		

IE_Type	6 bits	
Length	6 bits	
IE specific field	Variable	
}		

8.4.5.8.1 IE Types Definition

Table 303c defines the EN-MAP IE type encoding.

Table 303c EN-MAP IE type encoding

Type	EN-MAP type encoding	En-MAP IE name	format
0	0b 000000	DL access IE	See 8.4.5.8.2
1	0b 000001	UL access IE	See 8.4.5.8.3
2	0b 000010	DL/UL access IE	See 8.4.5.8.4
3	0b 000011	DL AAS IE	See 8.4.5.3.3 (removing the 'Extended DIUC' and 'Length' fields)
4	0b000100	DL TD_Zone IE	See 8.4.5.3.4 (removing the 'Extended DIUC' and 'Length' fields)
5	0b 000101	Channel measurement IE	See 8.4.5.3.5 (removing the 'Extended DIUC' and 'Length' fields)
6	0b 000110	Data_location_in_another_BS IE	See 8.4.5.3.6 (removing the 'Extended DIUC' and 'Length' and 'reserved' fields and insert'CID(16 bits)' field)
7	0b 000111	MIMO_DL_Basic IE	See 8.4.5.3.8 (removing the 'Extended DIUC' and 'Length' fields)
8	0b 001000	MIMO_DL_Enhanced IE	See 8.4.5.3.9 (removing the 'Extended DIUC' and 'Length' fields)
9	0b 001001	DL PUSC burst allocation in other segment IE	See 8.4.5.3.12 (removing the 'Extended DIUC' and 'Length' fields)
10	0b 001010	HO active anchor DL MAP IE	See 8.4.5.3.13 (removing the 'Extended DIUC' and 'Length' fields)
11	0b 001011	HO Active Anchor DL MAPIE	See 8.4.5.3.14 (removing the 'Extended DIUC' and 'Length' fields)
12	0b001100	HO CID Translation IE	See 8.4.5.3.15 (removing the 'Extended DIUC' and 'Length' fields)
13	0b 001101	MIMO_in_another_BS IE	See 8.4.5.3.16 (removing the 'Extended DIUC' and 'Length' fields)
14	0b 001110	Macro_DL_Basic IE	See 8.4.5.3.17 (removing the 'Extended DIUC' and 'Length' fields)
15	0b 001111	Power control IE	See 8.4.5.4.5 (removing the 'Extended DIUC' and 'Length' and 'reserved' fields and insert'CID(16 bits)' field)
16	0b 010000	UL AAS IE	See 8.4.5.3.6 (removing the 'Extended DIUC' and 'Length' fields)
17	0b 010001	PAPR reduction, safty zone and sounding zone allocation IE	See 8.4.5.3.7 (removing the 'Extended DIUC' and 'Length' fields)
18	0b 010010	MIMO UL Basic IE	See 8.4.5.3.11 (removing the 'Extended DIUC' and 'Length' fields)
19	0b 010011	CQICH alloc IE	See 8.4.5.3.2 (removing the 'Extended

			DIUC' and 'Length' fields and inserting 'CID(16 bits)' field)
20	0b010100	UL physical Modifier IE	See 8.4.5.3.14 (removing the 'Extended DIUC' and 'Length' fields)
21	0b 010101	CQICH Enhance Allocation IE	See 8.4.5.3.15 (removing the 'Extended DIUC' and 'Length' fields)
22	0b 010110	UL PUSC Burst Allocation in other segment	See 8.4.5.3.16 (removing the 'Extended DIUC' and 'Length' fields)
23	0b 010111	HO active anchor UL MAP IE	See 8.4.5.3.18 (removing the 'Extended DIUC' and 'Length' fields)
24	0b 011000	HO Active Anchor UL MAPIE	See 8.4.5.3.19 (removing the 'Extended DIUC' and 'Length' fields)
25	0b 011001	Fast ranging IE	See 8.4.5.3.20 (removing the 'Extended DIUC' and 'Length' fields)
26-63	0b 011010-0b111111	Reserved for future use	

8.4.5.8.2 DL access IE

The DL access IE defines a DL two-dimensional region for a MSS to access.

Table 303d DL access_IE Format

Syntax	Size	Notes
DL_access_IE() {		
CID	16 bits	
DIUC	4 bits	
OFDMA symbol offset	8 bits	
Subchannel offset	6 bits	
Boosting	3 bits	
No. OFDMA symbols	8 bits	
No. Subchannels	8 bits	
Repetition Coding Indication	2 bits	
Padding bits	variable	To align byte boundary
}		

8.4.5.8.3 UL access IE

The UL access IE defines an UL duration for a MSS to access.

Table 30[3]e UL access_IE Format

Syntax	Size	Notes
UL_access_IE() {		
CID	16 bits	
UIUC	4 bits	
Duration	10 bits	In OFDMA slot (see 8.4.3.1)
Repetition code indication	2 bits	0b00: no repetition coding 0b01: Repetition coding of 2 used

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		0b10: Repetition coding of 4 used 0b11: Repetition coding of 6 used
}		

8.4.5.8.4 DL/UL access IE

The UL access IE defines a DL two-dimensional region and a UL duration for a MSS to access.

Table 303f DL/UL access_IE Format

Syntax	Size	Notes
DL/UL_access_IE() {		
CID	16 bits	Basic CID if the UL resource allocation can be used by any UL connections; UL connection ID if the UL resource allocated is for a specific UL connection (since DL connection CID always appears in MAC header)
DIUC		
OFDMA symbol offset	8 bits	
Subchannel offset	6 bits	
Boosting	3 bits	
No. OFDMA symbols	8 bits	
No. Subchannels	8 bits	
Repetition Coding Indication	2 bits	
UIUC	4 bits	
Duration	10 bits	In OFDMA slot (see 8.4.3.1)
Repetition code indication	2 bits	0b00: no repetition coding 0b01: Repetition coding of 2 used 0b10: Repetition coding of 4 used 0b11: Repetition coding of 6 used
}		

Remedy 3:
To allow 802.16e MSS to avoid processing regions designated for 802.16d SS, we introduce a new IE called the Skip_IE. The Skip_IE is used to toggle the enabling and disabling of processing of regions designated by iEs following the Skip_IE.

[Add the follow Section 8.4.5.3.5.19]

8.4.5.3.5.19 Skip IE

This IE is sent by BS in DL-MAP/Compressed DL-MAP message as a broadcast IE. This IE is used to toggle the enabling and disabling of processing of regions designated by IEs following the Skip_IE. When the first Skip_IE is encountered, the MSS does not process the region designated by IEs following the Skip_IE. When a second Skip_IE is encountered, the MSS revert back to processing the region designated by the iEs following the Skip_IE when applicable. When the next Skip_IE is encountered, the MSS again disables processing of regions designated by subsequent iEs. This process continues until the end of the DL-MAP/Compressed DL-MAP.

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Table 298j Skip_IE Format

Syntax	Size	Notes

Skip_IE() {		
Extended DIUC	4 bits	0x0A
Length	4 bits	
Skip till the end of DL-MAP indication	1 bit	If set to 1, the MSS can skip the processing of subsequent IEs in the DL-MAP If set to 0, the MSS toggle the enabling and disabling of processing of the regions designated by the IEs, following the Skip_IE
Reserved	7 bits	
}		

Remedy 4:
Add OFDMA symbol offset to AAS_DL_IE() and STC_Zone_IE() so that DL burst allocations in the EN_MAP message have the same reference as DL burst allocations in the DL-MAP message. The AAS_DL_IE() and STC_Zone_IE() only appear in the DL-MAP and shall not appear in the EN_MAP.

[Modify Section 8.4.5.3.3, Table 276]

Table 276—OFDMA downlink AAS IE

Syntax	Size	Notes
AAS_DL_IE() {		
Extended DIUC	4 bits	AAS = 0x02
Length	4 bits	Length = 0x03
Permutation	2 bits	0b00 = PUSC permutation 0b01 = FUSC permutation 0b10 = Optional FUSC permutation 0b11 = adjacent-subcarrier permutation
Preamble indication	2 bits	0b00 = No preamble 0b01 = Preamble used 0b10-0b11 = *Reserved*
First bin index	6 bits	When Permutation=0b10, this indicates the index of the first band allocated to this AMC segment
Last bin index	6 bits	When Permutation=0b10, this indicates the index of the last band allocated to this AMC segment
OFDMA symbol offset	8 bits	
}		

AAS_DL_IE shall only be specified in the DL-MAP message. The zone permutation and boundaries shall apply to all allocations described in subsequent EN-MAP message(s) in the same frame.

[Modify Section 8.4.5.3.4, Table 277a]

Table 277a—OFDMA downlink TD_ZONE IE format

Syntax	Size (bits)	Notes
STC_ZONE_IE() {		
Extended DIUC	4	STC/ZONE = 0x01
Length	4	Length = 0x02
Permutation	2	00 = PUSC permutation 01 = FUSC permutation 10 = Optional FUSC permutation 11 = Optional adjacent subcarrier permutation
Use All SC indicator	1	0 = Do not use all subchannels 1 = Use all subchannels
STCTransmit Diversity	2	0b00 = No transmit diversity 0b01 = STC using 3 antennas 0b10 = STC using 4 antennas 0b11 = FHDC using 2 antennas
Matrix indicator	2	Antenna STC/FHDC matrix (see 8.4.8) 00 = Matrix A 01 = Matrix B 10 = Matrix C (applicable to 3 or 4 antennas only) 11 = *reserved*
IDcell	6	
Midamble presence	1	0 = not present 1 = present at the first symbol in STC zone
Midamble boosting	1	0 = no boost 1 = Boosting (3dB)
2/3 antennas select	1	0 = STC using 2 antennas 1 = STC using 3 antennas Selects 2/3 antennas when STC = 01
OFDMA symbol offset	8 bits	
}		

Zone permutation changes shall only be specified in the DL-MAP message. The zone permutation and boundaries shall apply to all allocations described in subsequent EN-MAP message(s) in the same frame. STC changes may be specified in EN-MAP message(s), in which case any instructed permutation changes shall be ignored.

Remedy 5:
Add Slot offset field to AAS_UL_IE() and STC_Zone_IE() so that the first UL burst allocation in UL-MAP message or EN-MAP message is with respect to the slot offset from the beginning of the zone. In this way, UL burst allocations in UL-MAP and EN-MAP

messages can be aligned.

[Modify Section 8.4.5.4.6, Table 291]

Table 291—OFDMA uplink AAS IE

Syntax	Size	Notes
AAS_UL_IE() {		
Extended UIUC	4 bits	AAS = 0x02
Length	4 bits	Length = 0x03
Permutation	2 bits	0b00 = PUSC permutation 0b01 = Optional PUSC permutation 0b10 = adjacent-subcarrier permutation 0b11 = *Reserved*
OFDMA symbol offset	8 bits	
Preamble indication	2 bits	0b00 = No preamble 0b01 = Preamble used 0b10-0b11 = *Reserved*
First bin index	6 bits	When Permutation=0b10, this indicates the index of the first band allocated to this AMC segment
Last bin index	6 bits	When Permutation=0b10, this indicates the index of the last band allocated to this AMC segment
Slot offset	11 bits	The slot offset (according to data slot mapping order), relative to the start of the zone, from which the UL burst allocation begins in this zone.
Reserved	5 bits	
}		

[Modify Section 8.4.5.4.6, Table 291]

Table 292—OFDMA uplink ZONE IE format

Syntax	Size	Notes
ZONE_IE() {		
Extended DIUC	4 bits	ZONE = 0x04
Length	4 bits	Length = 0x03
OFDMA symbol offset	7 bits	

Permutation	2 bits	0b00 = PUSC permutation 0b01 = FUSC permutation 0b10 = Optional FUSC permutation 0b11 = Adjcent subcarrier permutation
PUSC UL_IDcell	7 bits	
Slot offset	11 bits	The slot offset (according to data slot mapping order), relative to the start of the zone, from which the UL burst allocation begins in this zone.
Reserved	5 bits	
}		