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Re:	802.16 Working Group Letter Ballot #26
Abstract	UL MAP overhead has been identified as a serious performance issue in 802.16e systems. This contribution describes some considerations to reduce the MAP overhead and thus improve over all system capacity. We take care to only change the way information is encoded (syntactical changes only) in the UL MAP, but preserve all the protocol procedures to process the information. Essentially, no new functionalities are introduced in this proposal.
Purpose	To be discussed and adopted by 802.16 Rev2.
Notice	
Release	
Patent Policy	

Considerations for UL MAP Overhead Reduction

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1 Introduction

UL MAP overhead has been identified as a serious performance issue in 802.16e systems. This contribution describes some considerations to reduce the MAP overhead and thus improve over all system capacity. We take care to only change the way information is encoded (syntactical changes only) in the MAP, but preserve all the protocol procedures to process the information. Essentially, no new functionalities are introduced in this contribution.

2 Problem statement

MAP overhead has an impact on overall system capacity. Several parallel efforts are underway to reduce MAP overhead. In particular, the Persistent Allocation method takes advantage of the periodic nature of the traffic and has the potential for significant MAP overhead reduction. However, there are instances in which the persistent allocation method cannot be used; for example, the traffic is bursty rather then periodic, or HARQ retransmission of periodic allocation.

Some of the current inefficiencies of MAP IE encoding are born in the attempt to make the MAP IE general so that they can cover all supported use cases. This however comes at a cost. We propose to redesign few of the most commonly used IEs so that they tailored to the most common use cases.

3 Strategy for improving MAP encoding Efficiency

Encoding of MAP IEs can be improved by following few simple rules:

- Group like information so that information is not repeated unnecessarily
- Use variable length 'Duration' field where the actual size is dependant on the frame duration
- Group UIUC and repetition into one field
- Remove all spare bits used for bytes alignment
- Use LSB of Basic CID or RCID instead full 16 bits of the basic CID

4 Backward Compatibility Considerations

Any MAP overhead reduction mechanisms must be done in backward compatible manner. It would be highly desirable to establish a uniform and consistent approach for Rev2 MAP overhead reduction mechanisms.

This section discusses several alternatives for introducing new MAP IEs while preserving backward compatibility.

4.1 Alternative 1: Extension Using the DIUC/UIUC Code Space

Currently reserved code points for MAP IE extension:

- Extended DIUC has 5 reserved code: 05, 06, 09, 0D, 0E
- Extended-2 DIUC has 2 reserved codes: D, F

- Extended UIUC has 6 reserved codes: 6, B to F
- Extended-2 UIUC has 4 reserved codes: 5, B, C, D

The Length of the Unspecified Data field in Extended DIUC/UIUC is limited to 15 bytes while in Extended-2 DIUC/UIUC can support IEs up to 255 bytes. Therefore, the Extended-2 codes space is more attractive code space for new IEs.

Depending on the number of IEs that will be added in Rev 2, it is possible to continue to consume these code points (not recommended) or create another layer of encapsulation for the new IEs (recommended with a lot of reluctance). An example of creating another layer of encapsulations for the new IEs is shown in the tables below.

One more Encapsulation Layer for DL MAP IEs

Syntax	Size (bits)	Comments
DL-MAP_IE() {		
DIUC	4 bits	DIUC = 14 indicating extended-2 DIUC IE
Extended-2 DIUC	4 bits	Extended-2 DIUC = TBD
Unspecified Data	8 bits	Length in bytes max of 255 byte
New Rev 2 IE type	TBD	New code space for Rev 2 DL MAP IEs

One more Encapsulation Layer for DL MAP IEs

Syntax	Size (bits)	Comments
UL-MAP_IE() {		
UIUC	4 bits	UIUC = 11 indicating extended-2 UIUC IE
Extended-2 UIUC	4 bits	Extended-2 UIUC == TBD
Length	8 bits	Length in bytes max of 255 byte
New Rel 1.x IE type	TBD	New code space for UL MAP IEs

4.2 Alternative 2: Extension using DL Skip IE

The DL Skip IE can be used to delineate between 802.16e DL MAP IEs and new Rev2 DL MAP IEs. The mechanism for the Skip IE is defined in section 8.4.5.3.20.2 Skip IE of 802.16e. 802.16e Rev 1 compatible MS will skip processing any remaining DL MAP IEs. Rev 2 compatible MS, will know to ignore the Skip IE and continue processing any (new or old) IEs following the skip IE. The advantage of using the DL Skip IE is that is that there is no need to create another layer of encapsulation for DL MAP IEs. The disadvantage of using the DL Skip IE is that there is no corresponding mechanism in the UL.

5 Proposals for UL MAP Overhead Reduction

As the most commonly used UL data allocation IEs are the UL MAP IEs with UIUC=1 to 10, HARQ UL MAP IEs with Chase Subburst IEs, and HARQ UL MAP IEs with IR CC Subburst IEs, the contribution focuses on the overhead reductions in these three use cases.

5.1 Enhanced UL MAP IE

This IE can be used when advantageous instead of the OFDMA UL MAP IE of table 431 for UIUC 1-10. All protocol procedures applicable to the OFDMA UL MAP IE of table 431 also apply to the Enhanced UL MAP IE described in this contribution without modifications. There is no need to have new protocol procedures to support this Enhanced UL MAP IE.

Table 1: Enhanced UL MAP IE Format

Syntax	Size (bits)	Comments
Enhanced UL MAP IE () {		
Number of sub-bursts	5	Allowing up to 32 sub-burst in a single structure
For (i=0;i<number of sub-burst; i++) {		
LSB of basic CID	Variable	Size of LSB is defined in UCD; allow each system based on the number of supported MS to trim the size of the LSB field;
Duration	Variable	Frame duration dependant: 5 ms = 8 bits 10 ms = 9 bits 20 ms = 10 bits
UIUC Indicator	1	If Sub-Burst UIUC Indicator is 1, it indicates that UIUC is explicitly assigned for this subburst. Otherwise, this sub-burst will use the same UIUC as the previous sub-burst specified in this Enhanced UL MAP IE. For the first sub-burst in the IE, this indicator shall be 1.
If (UIUC indicator == 1)		
UIUC/Repetition	4	As per UCD enhanced burst profile definition
}		
Padding for byte alignment		
}		

Map overhead saving compared to exiting UL MAP IE of 32 bits, consider:

- 16 UL allocations
- 4 different MCS groups

The saving is about 40%.

5.2 Enhanced UL Chase Combine HARQ IE

This IE can be used, when advantageous, instead of the HARQ UL MAP IE of table 483 and UL HARQ Chase Sub-burst IE of table 484. All protocol procedures applicable to the OFDMA UL MAP IE of table 431 also apply to the Enhanced UL Chase Combined HARQ IE described in this contribution without modifications. There is no need to have new protocol procedures to support this Enhanced UL MAP IE.

Note that many optional parameters have been removed so that we can achieve the minimum overhead for the most commonly used cases. If any of the optional features are needed, the HARQ UL MAP IE of table 483 can be used.

Table 2: Enhanced UL Chase Combine HARQ IE Format

Syntax	Size (bits)	Comments
Enhanced UL Chase Combine HARQ IE () {	TBD	
Number of sub bursts	5	allowing up to 32 sub burst per IE
For (i=0;i<number of sub-burst; i++)		
LSB of basic CID	Variable	Size of LSB is defined in UCD; allow each system based on the number of supported MS to trim the size of the LSB

		field;
Duration	Variable	Frame duration dependant: 5 ms = 8 bits 10 ms = 9 bits 20 ms = 10 bits
ACID	4	
AI_SN	1	
ACK disable	1	
UIUC Indicator	1	If Sub-Burst UIUC Indicator is 1, it indicates that UIUC is explicitly assigned for this subburst. Otherwise, this sub-burst will use the same UIUC as the previous sub-burst. If i=0 then this indicator shall be 1.
If (UIUC indicator == 1)		
UIUC/Repetition	4	As per UCD enhanced burst profile definition
Padding for byte alignment		
}		

Map overhead saving compared to exiting UL MAP Chase HARQ IE, consider:

- 16 UL allocations
- 4 different MCS groups

The saving is about 20%.

5.3 Enhanced UL HARQ IR CC IE

This IE can be used, when advantageous, instead of the HARQ UL MAP IE of table 483 and UL HARQ IR CC Sub-burst IE of table 486. All protocol procedures applicable to the OFDMA UL MAP IE of table 431 also apply to the Enhanced UL HARQ CTC IE described in this contribution without modifications. There is no need to have new protocol procedures to support this Enhanced UL MAP IE

Table 3: Enhanced UL IR HARQ CC IE Format

Syntax	Size (bits)	Comments
Enhanced UL IR HARQ CC IE () {	TBD	
Number of sub bursts	5	allowing up to 32 sub burst per IE
For (i=0;i<number of sub-burst; i++)		
LSB of basic CID	Variable	Size of LSB is defined in UCD; allow each system based on the number of supported MS to trim the size of the LSB field;
Duration	Variable	Frame duration dependant: 5 ms = 8 bits 10 ms = 9 bits 20 ms = 10 bits
SPID	2	As per 802.16 standard
ACID	4	
AI_SN	1	
ACK disable	1	
UIUC Indicator	1	If Sub-Burst UIUC Indicator is 1, it indicates that UIUC is explicitly assigned for this subburst. Otherwise, this sub-burst will use the same UIUC as the previous sub-burst. If i=0 then this indicator shall be 1.
If (UIUC indicator == 1)		
UIUC/Repetition	4	As per UCD enhanced burst profile definition
Padding for byte alignment		
}		

Map overhead saving compared to exiting UL MAP IR HARQ CC IE, consider:

- 16 UL allocations
- 4 different MCS groups

The saving is about 20%.

6 Suggested Changes in Rev2/D1

In Rev2/D1, add the contents the following, where new text is marked by blue; deleted text is marked in ~~red with strikethrough~~:

Add new sections in 8021.6 Rev2/D, section 8.4.5.4 UL MAP IE Format after 8.4.5.4.28

8.4.5.4.29 Enhanced UL MAP IE

The Enhanced UL MAP IE defines UL bandwidth allocation for data grant burst profile. It follows the same protocol rules defined in Section 8.4.5.4 UL-MAP IE for data grant burst profile allocations.

The format of the Enhanced UL MAP IE is defined in Table XX1.

Table XX1: Enhanced UL MAP IE Format

Syntax	Size (bits)	Comments
Enhanced UL MAP IE () {	TBD	
Number of sub-bursts	5	
For (i=0;i<number of sub-burst; i++)		
LSB of basic CID	Variable	Size of LSB is defined in UCD;
Duration	Variable	Frame duration dependant: 5 ms = 8 bits 10 ms = 9 bits 20 ms = 10 bits
UIUC Indicator	1	If Sub-Burst UIUC Indicator is 1, it indicates that UIUC is explicitly assigned for this subburst. Otherwise, this sub-burst will use the same UIUC as the previous sub-burst. If i=0 then this indicator shall be 1.
If (UIUC indicator == 1)		
UIUC/Repetition	4	Burst profile used for the burst as defined in the UDC message
Padding for byte alignment		
}		

8.4.5.4.30 Enhanced UL Chase Combine HARQ IE

The Enhanced UL Chase Combine HARQ IE defines UL bandwidth allocation for data grant burst profile. It follows the same protocol rules defined in Section 8.4.5.4.24 HARQ UL-MAP IE.

The format of the Enhanced UL MAP IE is defined in Table XX2.

Table XX2: Enhanced UL Chase Combine HARQ IE Format

Syntax	Size (bits)	Comments
Enhanced UL Chase Combine HARQ IE () {	TBD	
Number of sub bursts	5	
For (i=0;i<number of sub-burst; i++)		
LSB of basic CID	Variable	Size of LSB is defined in UCD
Duration	Variable	Frame duration dependant: 5 ms = 8 bits

		10 ms = 9 bits 20 ms = 10 bits
ACID	4	
AI_SN	1	
ACK disable	1	
UIUC Indicator	1	If Sub-Burst UIUC Indicator is 1, it indicates that UIUC is explicitly assigned for this subburst. Otherwise, this sub-burst will use the same UIUC as the previous sub-burst. If i=0 then this indicator shall be 1.
If (UIUC indicator == 1)		
UIUC/Repetition	4	Burst profile used for the burst as defined in the UDC message
Padding for byte alignment		
}		

8.4.5.4.31 Enhanced UL IR CC HARQ IE

The Enhanced UL IR CC HARQ IE defines UL bandwidth allocation for data grant burst profile. It follows the same protocol rules defined in Section 8.4.5.4.24 HARQ UL-MAP IE.

The format of the Enhanced UL MAP IE is defined in Table XX3.

Table XX3: Enhanced UL IR HARQ CC IE Format

Syntax	Size (bits)	Comments
Enhanced UL IR HARQ CC IE () {	TBD	
Number of sub bursts	5	allowing up to 32 sub burst per IE
For (i=0;i<number of sub-burst; i++)		
LSB of basic CID	Variable	Size of LSB is defined in UCD;
Duration	Variable	Frame duration dependant: 5 ms = 8 bits 10 ms = 9 bits 20 ms = 10 bits
SPID	2	
ACID	4	
AI_SN	1	
ACK disable	1	
UIUC Indicator	1	If Sub-Burst UIUC Indicator is 1, it indicates that UIUC is explicitly assigned for this subburst. Otherwise, this sub-burst will use the same UIUC as the previous sub-burst. If i=0 then this indicator shall be 1.
If (UIUC indicator == 1)		
UIUC/Repetition	4	Burst profile used for the burst as defined in the UDC message
Padding for byte alignment		
}		

Add the following text to section 8.4.5.5 Burst Profile after table 499.

Table XX4 defines the format of the Enhanced Uplink Burst Profile TLV with type = yyy, which is used in the UCD message (6.3.2.3.3) for MS only. The UIUC/repetition field is associated with the UL burst profile and thresholds. The UIUC/repetition value is used in the UL-MAP message to specify the burst profile to be used for a specific UL burst.

Table XX4 – OFDMA Enhanced Uplink Burst Profile TLV for multiple FEC types

Syntax	Size(bits)	Notes
Enhanced Burst Profile {	--	--
Type = TBD	8	--

Length	8	--
Reserved	2	Shall be set to zero
Coding Type	2	0b00: BTC 0b01: CTC 0b10: ZT CC 0b11: LDPC
UIUC/Repetition	4	--
TLV encoded information	*Variable*	--
}	--	--

Add the following to section 11.3.1.1 Uplink burst profile encodings;

Table XX5—Enhanced UCD burst profile encodings—WirelessMAN-OFDMA

Name	Type (1 byte)	Length	Value (variable length)
FEC Code type and modulation	**TBD**	**1**	0 = QPSK (CC) 1/2 1 = QPSK (CC) 3/4 2 = 16-QAM (CC) 1/2 3 = 16-QAM (CC) 3/4 4 = 64-QAM (CC) 1/2 5 = 64-QAM (CC) 2/3 6 = 64-QAM (CC) 3/4 7 = QPSK (BTC) 1/2 8 = QPSK (BTC) 3/4 9 = 16-QAM (BTC) 3/5 10 = 16-QAM (BTC) 4/5 11 = 64-QAM (BTC) 5/8 12 = 64-QAM (BTC) 4/5 13 = QPSK (CTC) 1/2 14 = Reserved 15 = QPSK (CTC) 3/4 16 = 16-QAM (CTC) 1/2 17 = 16-QAM (CTC) 3/4 18 = 64-QAM (CTC) 1/2 19 = 64-QAM (CTC) 2/3 20 = 64-QAM (CTC) 3/4 21 = 64-QAM (CTC) 5/6 22 = QPSK (ZT CC) 1/2 23 = QPSK (ZT CC) 3/4 24= 16-QAM (ZT CC) 1/2 25= 16-QAM (ZT CC) 3/4 26= 64-QAM (ZT CC) 1/2 27= 64-QAM (ZT CC) 2/3 28= 64-QAM (ZT CC) 3/4 29 = QPSK (LDPC) 1/2 30= QPSK (LDPC) 2/3 A code 31= QPSK (LDPC) 3/4 A code 32 = 16-QAM (LDPC) 1/2 33 = 16-QAM (LDPC) 2/3 A code 34 = 16-QAM (LDPC) 3/4 A code 35 = 64-QAM (LDPC) 1/2 36 = 64-QAM (LDPC) 2/3 A code 37 = 64-QAM (LDPC) 3/4 A code 38 = QPSK (LDPC) 2/3 B code 39 = QPSK (LDPC) 3/4 B code 40= 16-QAM (LDPC) 2/3 B code 41 = 16-QAM (LDPC) 3/4 B code 42 = 64-QAM (LDPC) 2/3 B code 43 = 64-QAM (LDPC) 3/4 B code 44 = QPSK (CC with optional interleaver) 1/2 45 = QPSK (CC with optional interleaver) 3/4 46 = 16-QAM (CC with optional interleaver) 1/2 47 = 16-QAM (CC with optional interleaver) 3/4 48 = 64-QAM (CC with optional interleaver) 2/3 49= 64-QAM (CC with optional interleaver) 3/4 50 = QPSK (LDPC) 5/6 51 = 16-QAM(LDPC) 5/6 52 = 64-QAM(LDPC) 5/6

Table XX5—Enhanced UCD burst profile encodings—WirelessMAN-OFDMA (continue)

Name	Type (1 byte)	Length	Value (variable length)	
FEC Code type and modulation	**TBD**	**1**	53 = QPSK (CC) 1/2 , Rep2 54 = QPSK (CC) 1/2 , Rep4 55 = QPSK (CC) 1/2 , Rep6 56 = QPSK (CC) 3/4 , Rep2 57 = QPSK (CC) 3/4 , Rep4 58 = QPSK (CC) 3/4 , Rep6 59 = QPSK (BTC) 1/2 , Rep2 60 = QPSK (BTC) 1/2 , Rep4 61 = QPSK (BTC) 1/2 , Rep6 62 = QPSK (BTC) 3/4 , Rep2 63 = QPSK (BTC) 3/4 , Rep4 64 = QPSK (BTC) 3/4 , Rep6	64 = QPSK (CTC) 1/2 , Rep2 65 = QPSK (CTC) 1/2 , Rep4 66 = QPSK (CTC) 1/2 , Rep6 67 = QPSK (CTC) 3/4 , Rep2 68 = QPSK (CTC) 3/4 , Rep4 69 = QPSK (CTC) 3/4 , Rep6 70 = QPSK (ZT CC) 1/2 , Rep2 71 = QPSK (ZT CC) 1/2 , Rep4 72 = QPSK (ZT CC) 1/2 , Rep6 73 = QPSK (ZT CC) 3/4 , Rep2 74 = QPSK (ZT CC) 3/4 , Rep4 75 = QPSK (ZT CC) 3/4 , Rep6 Other codes as required