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Title	**Corrections for Supporting Multiple Sounding Zones**
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Re:	LB26 – IEEE802.16 REV2/D3.
Abstract	This contribution proposes corrections to the UL sounding signaling for when multiple sounding zones are present in a frame.
Purpose	Review and adopt.
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Corrections for Supporting Multiple Sounding Zones

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Introduction

The UL Sounding Signaling in Section 8.4.6.2.7 is currently specified to support the use of one or more sounding zones within an UL frame. When multiple sounding zones are specified in the UL MAP, the UL sounding command IE relates to the sounding zone described by the most recent PAPR Reduction Safety and Sounding Zone Allocation IE in the MAP. Unfortunately, if all the PAPR Reduction Safety and Sounding Zone Allocation IEs for the multiple sounding zones are all grouped together in the MAP, then there is no means of referring to any but the last sounding zone listed in the MAP. This problem was pointed out in [3], where the proposed solution was to permit only one sounding zone. However, IEEE 802.16 REV2-D3 clearly specifies that more than one sounding zone is permissible in the standard. This contribution fixes the methodology for scheduling users for sounding when there is more than one sounding zone.

Overview of proposed modifications

The proposed modification is straightforward and does not break backward compatibility with any mobile stations that are constructed to support UL Sounding as specified in [1] and profiled in [2] (hereby referred to as "legacy" mobiles). The proposed modification is to use two reserved bits near the beginning of the Sounding command IE to specify which sounding zone is being referred to by the sounding command IE. In the proposed changes below, these two reserve bits are called the "Sounding Zone Indicator" field.

Backward compatibility can be insured because the legacy mobiles are designed to ignore the bits comprising the new "Sounding Zone Indicator" field and assume the sounding command refers to the sounding zone described by the most recent PAPR_Reduction_Safety_and_Sounding_Zone_Allocation_IE() in the UL-MAP message. The BS must account for this behavior by the legacy mobiles when scheduling mobiles to sound, which effectively means that all legacy mobiles must be scheduled in the sounding zone described by the last PAPR_Reduction_Safety_and_Sounding_Zone_Allocation_IE() in the UL-MAP, which is not an unreasonable restriction.

Proposed Text Changes

[Table 462 – UL Sounding Command IE Format as is currently in REV2/D3]

[Additions in underlined blue. Deletions in ~~strikethrough red~~.]

Syntax	Size (Bit)	Notes
UL_Sounding_Command_IE(){	--	--

Extended-2 UIUC	4	UL_Sounding_Command_IE() = 0x04
Length	8	*variable*
Sounding_Type	1	0 = Type A 1 = Type B
Send Sounding Report Flag	1	-
Sounding_Relevance_Flag	1	0 = Sounding relevance is the same for all CIDs 1 = Sounding relevance is specified for each CID
if(Sounding_Relevance_Flag == 0) {	-	-
Sounding_Relevance	1	0 = All CIDs respond in the frame carrying the instruction 1 = All CIDs respond in next frame
~~*Reserved*~~	~~2~~	~~Shall be set to zero.~~
} else {	-	-
Reserved	~~3~~ 1	Shall be set to zero.
}	-	-
Sounding zone indicator	2	Indicates for which sounding zone this IE is relevant
Include additional feedback	2	0b00 = No additional feedback 0b01 = Include channel coefficients (see 8.4.6.2.7.3) 0b10 = Include received pilot coefficients 0b11 = Include feedback message
if (Sounding_Type == 0) {	-	-
Num_Sounding_symbols	3	Total number of sounding symbols being allocated, from 1 (0b000) to 2^3 = 8 (0b111)
reserved	1	Shall be set to zero
for(i=0; i<Num_Sounding_symbols;i++){	-	-
Separability Type	1	0: occupy all subcarriers in the assigned bands 1: occupy decimated subcarriers
if (Separability type == 0) {	-	(using cyclic shift separability)

Max Cyclic Shift Index P	3	0b000: P = 4 0b001: P = 8 0b010: P = 16 0b011: P = 32 0b100: P = 9 0b101: P = 18 0b110–0b111: *Reserved*
Reserved	1	Shall be set to zero.
} else {	-	(using decimation separability)
Decimation Value *D*	3	Sound every D_{th} subcarrier within the sounding allocation. Decimation value *D* is 2 to the power of (1 plus this value), hence 2,4,8,… up to maximum of 128, and 0b111 means decimation of 5.
Decimation offset randomization	1	0 = no randomization of decimation offset 1 = decimation offset pseudo-randomly determined
}		
Sounding symbol index	3	Symbol index within the Sounding Zone, from 1 (value 0b000) to $2^3 = 8$ (value 0b111)
Number of CIDs	7	Number of CIDs sharing this sounding allocation
Reserved	1	Shall be set to zero.
for (j = 0; j < Num. of CIDs; j++) {	-	-
Shorted basic CID	12	12 LSBs of the MS basic CID value
Power Assignment Method	2	0b00 = Equal power 0b01 = *Reserved* 0b10 = Interference dependent; per subcarrier power limit 0b11 = Interference dependent; total power limit.
Power boost	1	0 = No power boost 1 = Power boost
Multi-Antenna Flag	1	0 = MS sounds first antenna only 1 = MS sounds all antennas
Allocation Mode	1	0: Normal 1: Band AMC
If (Allocation Mode == 1) {	-	-
Band bit Map	12	See logical band defined in 8.4.6.3.2.
Reserved	2	Shall be set to zero.

} Else {	-	-
Starting Frequency Band	7	Out of 96 bands at most (FFT size dependent)
Number of frequency bands	7	Contiguous bands used for sounding
}	-	-
If (Sounding Relevance Flag == 1) {	-	-
Sounding_Relevance	1	-
} else {	-	-
Reserved	1	Shall be set to zero
}		
if (Separability Type == 0) {		
Cyclic time shift index *n*	5	Specifies a frequency-domain phase ramp to be multiplied to the Golay Sequence as shown in Equation 83. The value of n ranges from 0 to P-1.
} else {	-	-
Decimation Offset d	6	Relative starting offset position for the first sounding occupied subcarrier in the sounding allocation
If (Include additional feedback == 0b01) {	-	
Use same symbol for additional feedback	1	0 = The additional feedback is sent in the symbol(s) following the allocated sounding symbol. 1 = The additional feedback is sent in the same symbol as the allocated sounding symbol.
Reserved	2	Shall be set to zero
} else {		
Reserved	3	Shall be set to zero.
}		
}		
Periodicity	3	0b000 = Single command, not periodic, or ter-minate periodicity. Otherwise, repeat sounding once per *r* frames, where $r = 2^{(n-1)}$, where n is the decimal equivalent of the periodicity field.

}	-	-
}	-	-
} else {	-	-
Permutation	3	0b000 = PUSC perm 0b001 = FUSC perm 0b010 = Optional FUSC perm 0b011 = PUSC-ASCA 0b100 = TUSC1 0b101 = TUSC2 0b110 = AMC (2x3) 0b111 = *Reserved*
DL_PermBase	6	-
Num_Sounding_symbols	3	-
for (i = 0; i < Num_Sounding_symbols; i++){	-	-
Number of CIDs	7	-
Reserved	1	Shall be set to zero.
for (j = 0; j < Number of CIDs; j++) {		
Shortened basic CID	12	12 LSBs of the MS basic CID value
If(Sounding_Relevance_Flag == 1){	-	-
Sounding_Relevance	1	0 = Respond in the frame carrying the instruction 1 = Respond in next frame
Reserved	3	Shall be set to zero
}	-	-
Subchannel offset	7	The lowest index subchannel used for carrying the burst, starting from subchannel 0
Power boost	1	0 = No power boost 1 = Power boost
Number of subchannels	3	The number subchannels with subsequent indexes, used to carry the burst.
Periodicity	3	0b000 = Single command, not periodic, or terminate periodicity. Otherwise, repeat sounding once per *r* frames, where $r = 2^{(n-1)}$, where *n* is the decimal equivalent of the periodicity field.

Power Assignment Method	2	0b00 = Equal power 0b01 = *Reserved* 0b10 = Interference dependent; per subcarrier power limit 0b11 = Interference dependent; total power limit
}	-	-
}	-	-
Padding	*Variable*	Pad IE to octet boundary. Bits shall be set to 0
}	-	-

[Paragraph starting on line 13 of page 888, Section 8.4.6.2.7.1]

[Additions in underlined blue. Deletions in ~~strikethrough red~~.]

In order to enable UL sounding, in UL-MAP, a BS transmits UIUC = 13 with the PAPR_Reduction_Safety_and_Sounding_Zone_Allocation_IE() (see Table 363) to indicate the allocation of an UL sounding zone within the frame. The Sounding Zone is a region of one or more OFDMA symbol intervals in the UL frame that is used by the MS to transmit sounding signals to enable the BS to rapidly determine the channel response between the BS and the MS. The BS may command an MS to transmit a sounding signal (defined below) at one or more OFDMA symbols within the sounding zone by transmitting the UL-MAP message UL_Sounding_Command_IE() to provide detailed sounding instructions to the MS. If periodic sounding is instructed by the BS, it is the responsibility of the BS to continue to signal the PAPR_Reduction_Safety_and_Sounding_Zone_Allocation_IE() in every appropriate frame. The UL_Sounding_Command_IE() of type A instructs the MS to transmit the specific sounding signal(s) at one or more specific symbol interval(s) within the sounding zone and specifies the specific sounding frequency band(s) to be occupied within each of these sounding symbol(s). The UL_Sounding_Command_IE() of type B is similar to the UL_Sounding_Command_IE() of type A except the frequency band(s) are allocated according to a specified DL subcarrier permutation. ~~When multiple sounding zones are defined in the UL-MAP, a UL_Sounding_Command_IE() relates to a sounding allocation in the sounding zone described by the most recent PAPR_Reduction_Safety_and_Sounding_Zone_Allocation_IE() in the UL-MAP message.~~ When multiple sounding zones are defined in the UL-MAP or the UCD, the field “sounding zone indicator” is used to explicitly specify for which sounding zone this sounding command IE is referring. Sounding zones are numbered (starting from zero) according to the order in which they appear in the UL MAP or the UCD.

References

[1] IEEE P802.16-2004/Cor2/D4 – Draft Corrigendum to IEEE Std 802.16-2004, May 22, 2007

[2] WiMAX Forum™ Mobile System Profile – Release 1.0 Approved Specification (Revision 1.4.0: 2007-05-02).

[3] Y. Kim, F. W. Vook, A. Raghavan, D. Pechner, "RPD on Clarifications on UL Sounding", WiMAX Forum Technical Working Group – Recommended Practice Document Contribution, 8/12/2007