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Re:	IEEE 802.16m-08/005, "Call for Contributions on Project 802.16m System Description Document (SDD)". Target topic: "Downlink Control Structure."
Abstract	The contribution proposes a high level working assumption for DL BCH/MAP control signaling in 16m/legacy mix operation, to be included in the 802.16m SDD.
Purpose	To be discussed and adopted by TGm for the 802.16m SDD.
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Proposed Working Assumption for DL Control Signaling (BCH/MAP) in 16m/Legacy Mix Operation

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1 Introduction

The contribution proposes a high-level working assumption for DL control signaling in 16m/legacy mixed operation. This contribution focuses on BCH and MAP (FCH and MAP in legacy terminology) signaling. We compare two signaling approaches to provide DL control information to 16m MS in the 16m/legacy mix operation; i.e. separate signaling versus shared signaling between 16m MS and legacy MS. Based on analysis results, we choose and propose a proper DL control signaling approach. The text proposal for inclusion in the 802.16m SDD is also provided.

2 802.16m DL control channel structure

A generic high level frame structure for 802.16m has been proposed in [1]. The proposed frame structure includes three basic DL control channels; SCH (synch channel), BCH (broadcasting channel), and MAP. The main information conveyed by each channel is the following:

- SCH: Reference signal for time/frequency synchronization and system acquisition
- BCH: System overhead information including frame configuration and MAP decoding
- MAP: Burst assignment

Figure 1 shows a high level structure of the three DL control channels and relevance among them. For system acquisition, 16m MS should first time- and frequency- synchronizes with a BS through SCH detection. After getting system/frame configuration and MAP decoding information from BCH, 16m MS can decode MAP message which includes burst assignment.

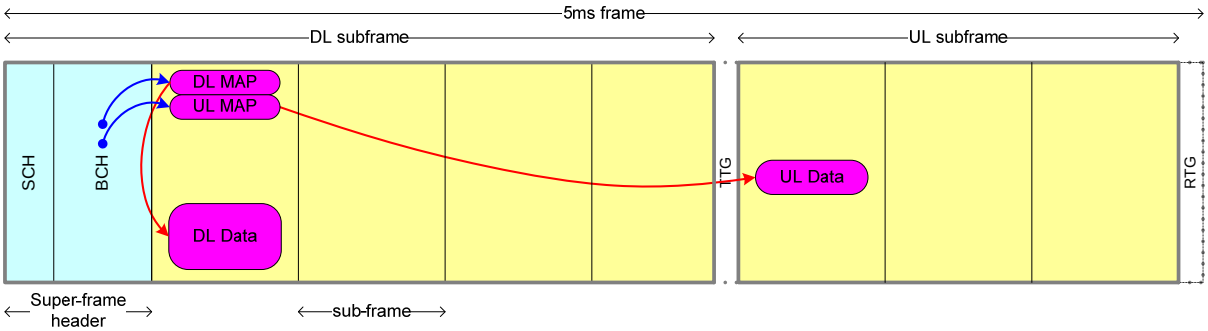


Figure 1: High level structure of basic DL control channels

We note that intention of this contribution is not to propose a specific DL control channel structure; rather, it is to address and resolve the high-level design issue in DL control structure for the 16m/legacy mixed operation.

3 DL BCH/MAP (FCH/MAP) signaling in the 16m/legacy mixed operation

As mentioned earlier, in this contribution the two BCH/MAP signaling approaches are considered for the 16m/legacy mix operation: Separate signaling versus shared signaling between 16m MS and legacy MS. The separate signaling means that a BS provides the different physical channels to 16m MS and legacy MS for BCH/MAP (FCH/MAP) transmissions: It implies that BCH and MAP signaling in the 16m/legacy mix operation is the same as in 16m only operation. The shared signaling means that DL control information for 16m MS are provided through legacy FCH and MAP. There may be various ways to share FCH and MAP signals between 16m MS and legacy MS.

Examples of the separate signaling and shared signaling are presented below:

- Example of the Separate Signaling:

  In this example, 16m DL zone is indicated by SCH and BCH which are located in super-frame header. Data bursts for 16m MS are assigned by 16m MAP. Thus, the DL control channel structure is the same as that for the 16m only operation shown in Figure 1. Then 16m MS does not need to decode legacy FCH and MAP messages. This example is illustrated in Figure 2.

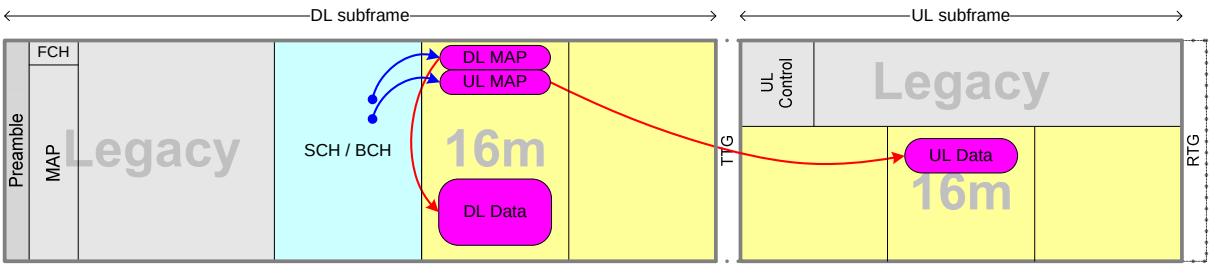


Figure 2: Example of the separate signaling

- Example of the Shared Signaling

  The shared signaling can be implemented in various ways. In this section, we show examples for the two extreme cases of the shared signaling.

  The 1st example is the case of partially shared signaling, which illustrated in Figure 3: In this example, data burst for 16m MS are assigned by a new 16m MAP message in 16m DL zone, but 16m DL zone indication for 16m MS is implemented by Zone S/W IE in the legacy MAP message. Thus, the 16m MS shall first decode legacy FCH and legacy MAP messages to decode the new 16m MAP.

  The 2nd example is the case of (relatively fully) shared signaling, which illustrated in Figure 4: In this example, 16m DL zone indication for 16m MS is implemented by Zone S/W IE in the legacy MAP message. In addition, the legacy MAP message is also used to convey burst assignment for 16m MS. The 16m MS shall decode legacy FCH and legacy MAP messages as same as legacy MS does.

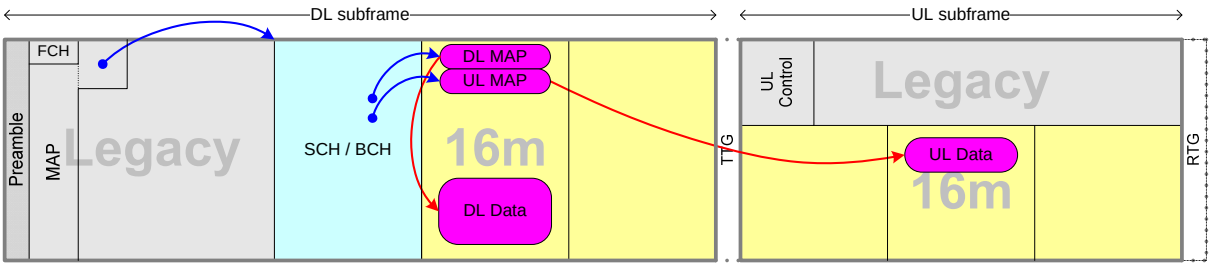


Figure 3: Example of the partially shared signaling

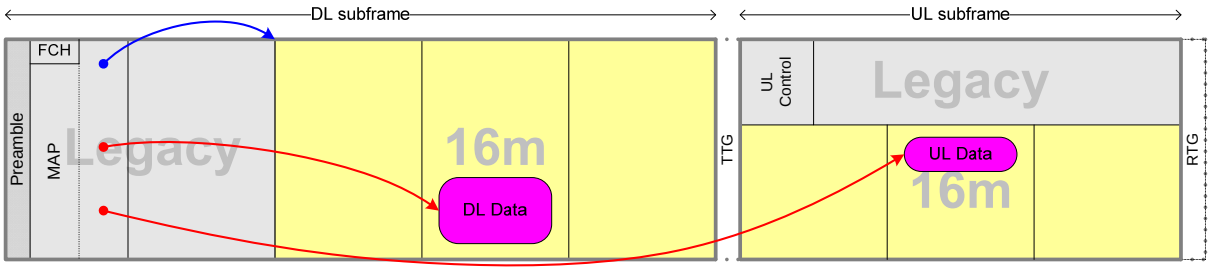


Figure 4: Example of the shared signaling

4 Comparison of the BCH/MAP signaling approaches

In this section, we compare the separate and the shared approaches for BCH/MAP signaling in the 16m/legacy mix operation. The advantage of the separate signaling is to allow 16m MS to access the system without decoding legacy control messages, so a DL control channel structure designed for the 16m only operation can be applied to the 16m/legacy mix operation. It leads to a smooth migration from the mix operation to 16m only operation. However, the concern about the separate signaling is an increase in total signaling overhead because a new control channel should be used together with the legacy control channels.

We compare the separate signaling with the partially shared signaling and the shared signaling.

4.1 Separate signaling vs. Partially shared signaling

The key difference between the separate signaling and the partially shared signaling is the 16m DL zone indication method: I.e. in the separate signaling by SCH/BCH, but in the partially shared signaling by Zone S/W IE in the legacy MAP message.

In terms of signaling overhead, the partial shared signaling may be expected to be better than the shared signaling because SCH may not be needed in the mix operation. However, as shown in another input contribution [2], SCH can be utilized as a reference signal for channel estimation of BCH message. If without SCH, a large number of pilot tones shall be included in BCH transmission block. SCH can take the place of those pilots. Therefore, considered an indispensable reference-signal overhead for the channel estimation of BCH, the SCH transmission does not increase the signaling overhead. Instead, by including SCH, a common structure for BCH can be implemented between the 16m only and the 16m/legacy mix operations.

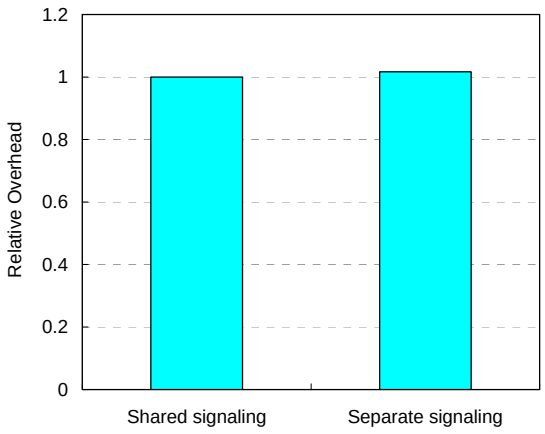
For the reason explained above, this contribution proposes the separate signaling.

4.2 Separate signaling vs. Shared signaling

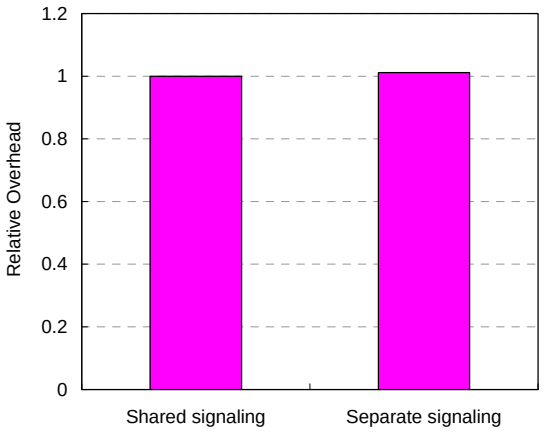
In this sub-section, signaling overheads of the separate signaling and the shared signaling are calculated and compared. Figure 5 shows the results of the signaling overhead for the two approaches. Figure 5 (a) and (b) are for the cases of DL SIMO/UL SIMO and DL MIMO/UL SIMO, respectively. For a fair and simple comparison, we assumed that the same physical channel is used both in legacy DL zone and 16m DL zone, i.e. DL PUSC. Hence, the signaling overhead can be defined as a ratio of the number of DL PUSC slots for SCH/BCH/MAP (or Preamble/FCH/MAP) transmission to total number of DL PUSC slots in DL sub-frame. The values shown in the figure are normalized by the overhead with shared signaling. For other details assumed in this analysis, see the appendix at the end of this contribution.

We can see in Figure 5 that the signaling overheads of the two approaches are almost the same. Although the overhead analysis in this contribution is based on the assumed control structure for 16m, it can be expected that the separate signaling overhead is not noticeably higher than the shared signaling. Moreover, considered various enhanced PHY schemes expected to be applied in 16m DL zone, the overhead for the separate signaling will be lower than the results shown in this analysis.

Since the analysis result shows no noticeable gain in overhead with the shared signaling, we propose the separate signaling.



(a) HARQ, DL – SIMO, UL - SIMO



(b) HARQ, DL – MIMO, UL - SIMO

Figure 5: SCH/BCH/MAP signaling overhead

5 Conclusion

In this contribution, we have compared the three approaches for DL control signaling in the 16m/legacy mixed operation. Based on the analysis results, the separate signaling between 16m MS and legacy MS is chosen and proposed as a proper DL control signaling for the 16m/legacy mix operation.

6 Text proposal for inclusion in the 802.16m SDD

Add the following text into the sub-clause of downlink control channel in [4]:

11.x Downlink control channel

… …

In the legacy support operation, BS shall transmit SCH, BCH, and MAP in order that a new MS can access the system without decoding legacy FCH and legacy MAP messages.

Appendix. Assumption and modeling for the overhead analysis

For both cases of the separate signaling and the shared signaling, the assumption for the overhead analysis are as follows: The 16m/legacy mix ratio of 3:2 (equal to the sub-frame division ratio of 16m to legacy), 3 bursts in 16m DL zone and 2 bursts in legacy DL zone, 3 bursts in 16m UL segment and 2 bursts in legacy UL segment, and the legacy MAP message is transmitted with QPSK, 1/2 code rate, and 6 repetition coding.

A.1 Separate signaling

Table 1 shows legacy messages and 16m control channels assumed in the overhead analysis of the separate signaling. In the 16m DL zone, the 16m MAP IEs are assumed to be transmitted with a separate coding per each MS and also the 16m MAP message are frequency-division multiplexed with data bursts [3]. Then power boosting scheme is applied to the 16m MAP message.

Table 1. DL control message configuration for the mix operation with separate signaling

(a) HARQ, SIMO for DL and UL

Message and its components			Assumption
Legacy	Preamble		
	FCH		
	MAP	Compressed DL-MAP	Include HARQ DL MAP IE, DL HARQ Chase sub-burst IE, Zone Switch IE
		Compressed UL-MAP	Include HARQ UL MAP IE, UL HARQ Chase sub-burst IE, CDMA Alloc IE
		CRC	
16m	Super-frame header	SCH	Occupies 6 OFDMA symbols per 20ms super-frame
		BCH	
	MAP	16m DL MAP IEs	Each MAP IE: 48 bits long, QPSK, code rate 1/2, 2 repetition, 16 bits CRC included
		16m UL MAP IEs	

(b) HARQ, MIMO for DL and SIMO for UL

Message and its components		Assumption
Legacy	Preamble	

	FCH		
	MAP	Compressed DL-MAP	Include Zone Switch IE, HARQ DL MAP IE, MIMO DL Chase HARQ sub-burst IE, Zone Switch IE
		Compressed UL-MAP	Include HARQ UL MAP IE, UL HARQ Chase sub-burst IE, CDMA Alloc IE
		CRC	
16m	Super-frame header	SCH	Occupies 6 OFDMA symbols per 20ms super-frame
		BCH	
	MAP	16m DL MAP IEs	Each MAP IE: 48 bits long, QPSK, code rate 1/2, 2 repetition, 16 bits CRC included
		16m UL MAP IEs	

A.2 Shared signaling

Table 2 shows legacy messages and 16m MAP IEs assumed in the overhead analysis of the shared signaling. In the table, the *16m DL MAP IE* and the *16m UL MAP IE* are dedicated for 16m MS operation. We assumed that the *16m DL MAP IE* and the *16m UL MAP IE* are comprised of 32 bits payload (the same as in the separate signaling), 8 bits DUIC/EDIUC, and 4 bits length field.

Table 2. DL control message configuration for the mix operation with shared signaling

(a) HARQ, SIMO for DL and UL

Message and its components		Assumption
Preamble		
FCH		
MAP	Compressed DL-MAP	Include HARQ DL MAP IE, DL HARQ Chase sub-burst IE
		Include *16m DL MAP IEs*
	Compressed UL-MAP	Include HARQ UL MAP IE, UL HARQ Chase sub-burst IE, CDMA Alloc IE
		Include *16m UL MAP IEs*
	CRC	

(b) HARQ, MIMO for DL and SIMO for UL

Message and its components		Assumption
Preamble		
FCH		
MAP	Compressed DL-MAP	Include Zone Switch IE, HARQ DL MAP IE, MIMO DL Chase HARQ sub-burst IE
		Include *16m DL MAP IEs*
	Compressed UL-MAP	Include HARQ UL MAP IE, UL HARQ Chase sub-burst IE, CDMA Alloc IE
		Include *16m UL MAP IEs*
	CRC	

References

[1] IEEE C80216m-08/062r1, “Proposed 802.16m Frame Structure.”

[2] IEEE C80216m-08/184, “Proposed Working Assumptions for DL Broadcasting Channel.”

[3] IEEE C80216m-08/185, “Multiplexing and Coding for MAP Transmission in IEEE 802.16m”

[4] IEEE 802.16m-08/003, “Draft IEEE 802.16m System Description Document.”