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Re:	IEEE P802.16e/D4-2004
Abstract	Definition for FCH transmission in FFT-128
Purpose	
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FCH transmission in FFT-128

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1. Introduction

In OFDMA mode, FCH message requires total of four subchannels per segment. In 128 FFT case, there are only total of three DL PUSC subchannels available for all three segments.

2. Details

The problem of transmitting FCH in FFT-128 stems from the low bandwidth and small number of subchannels.

(1) Transmission of FCH with repetition for each segment imposes a large overhead (4 slots = 8 symbols). In 1.25Mhz bandwidth and 5ms frames, only the FCH would take 16% of the frame.

(2) FCH has intrinsic repetition of 2 (due to duplication of 24 bits). In addition, since it is a very short burst, it has lower frame-error probability compared with other bursts using the same modulation and coding.

(3) Use of segmentation in FFT-128 does not seem likely, because of the low bandwidth and MAP overhead. The compressed MAP fixed parts are 80bit(DL)+40bit(UL)+32bit(CRC), and every IE is at least 36bit (DL) or 32bit (UL), so a compressed MAP with two DL bursts and one UL burst would take 256bit. In 1.25Mhz bandwidth even without repetition transmitting the maps will take 6 slots which are 12 symbols when using PUSC (reuse-1/3) with one subchannel per segment. In this case the are 25% of the frame for 5ms frames.

3. Proposed solutions

We propose two alternatives:

(1) Shorten FCH to 12 bits, duplicate 4 times, remove repetition (1 slot)

(2) Just remove repetition

The advantage of the 1st proposal is in enhanced performance of FCH decoding (about 2dB gain compared to (2)), while the advantage of the 2nd is keeping the same FCH structure and decoding procedure.

3.1. Alternative 1 (FCH12 x 4)

3.1.1. Description

The proposal is to modify the OFDMA FCH to a compressed version of half its original size (12 effective un-coded bits compared to its current 24 bits) satisfying the needs of 128 FFT case more efficiently.

In modifying the FCH message the following considerations are used:

1. Because of the small number of subchannels remaining in 128 FFT case, there is no need to more than 1 bit for “Used subchannel bitmap”, indicating either full use or 1/3 use of subchannels.
2. Will not include four reserved bits.

3. Will allocate only 6 bits to "DL-Map_Length". This means that the max length is 64 slots out of the worst case (for 20 msec, 1.25 MHz BW) ~100 slots. Note that for FFT-128, 64 slots are mapped to 43 symbols.

3.2.

3.2. Alternative 2 (FCH24 x 2)

The repetition on FCH will be reduced to 1, and it will occupy the first slot of each segment.

In PUSC mode it is unlikely that repetitions would be used, because of the large overhead. For maps transmitted in CC the sensitivity for reception of FCH will be better than this of the map, because of the duplication. For the case of maps transmitted in CTC, the sensitivity for reception of the map is about 1dB, and as shown in the figures below, the frame-error-rate for FCH without repetition is about 2e-3 at this point.

4. Proposed Text Changes

4.1. Text Changes for alternative 1 (FCH12 x 4)

4.1.1. Change 1

Change the Title of Table 266 to "**OFDMA downlink Frame Prefix format for all FFT sizes except 128**"

4.1.2. Change 2

Add the following text and table to the end of Section 8.4.4.3:

For the case of 128 FFT, the following compressed format shall be used for FCH.

Table xxx—OFDMA downlink Frame Prefix format for 128 FFT

Syntax	Size	Notes
DL_Frame_Prefix_Format() {		
Used subchannel indicator	1 bits	0: Subchannel 0 is used for segment 0, Subchannel 1 is used for segment 1, Subchannel 2 is used for segment 2, 1: Use all subchannels
Ranging_Change_Indication	1 bit	
Repetition_Coding_Indication	2 bits	0b 00 - No repetition coding on DL-MAP 0b 01 - Repetition coding of 2 used on DL-MAP 0b 10 - Repetition coding of 4 used on DL-MAP 0b 11 - Repetition coding of 6 used on DL-MAP
Coding_Indication	2 bits	0b00 - CC encoding used on DL-MAP 0b01 - BTC encoding used on DL-MAP 0b10 - CTC encoding used on DL-MAP 0b11 – ZT CC encoding used on DL-MAP
DL-Map_Length	6 bits	
}		

Before being mapped to the FCH, the 12-bit DL Frame Prefix shall be repeated 4 times to form a 48-bit block, which is the minimal FEC block size.

4.1.3. Change 3

Add the following text as the second paragraph of Section 8.4.4.4 at page 112, line 50:

8.4.4.4 Allocation of subchannels for FCH, and logical subchannel numbering
[Modify the text appearing in 802.16e and add the sentence marked below]

In PUSC, any segment used shall be allocated at least the same amount of subchannels in subchannel group #0. For FFT sizes other than 128, the ~~The~~ first 4 slots in the downlink part of the segment contain the FCH as defined in 8.4.4.2. These slots contain 48 bits modulated by QPSK with coding rate 1/2 and repetition coding of 4. For FFT-128 one slot in the downlink part of the segment is dedicated to FCH and repetition is not applied. The basic allocated subchannel sets for Segments 0, 1, and 2 are Subchannel Group #0, #2, #4 respectively. Figure 220 depicts this structure.

4.1.4. Change 4

8.4.4.3 DL Frame Prefix

[Add the following lines to table 266b]:

FFT size	Subchannel group #	Subchannel Range
128	0	0
	1	-
	2	1
	3	-
	4	2
	5	-

4.2. Changes for alternative 2 (FCH 24 x 2)

8.4.4.4 Allocation of subchannels for FCH, and logical subchannel numbering
[Modify the text appearing in 802.16e and add the sentence marked below]

In PUSC, any segment used shall be allocated at least the same amount of subchannels in subchannel group #0. For FFT sizes other than 128, the ~~The~~ first 4 slots in the downlink part of the segment contain the FCH as defined in 8.4.4.2. These slots contain 48 bits modulated by QPSK with coding rate 1/2 and repetition coding of 4. For FFT-128 one slot in the downlink part of the segment is dedicated to FCH and repetition is not applied. The basic allocated subchannel sets for Segments 0, 1, and 2 are Subchannel Group #0, #2, #4 respectively. Figure 220 depicts this structure.

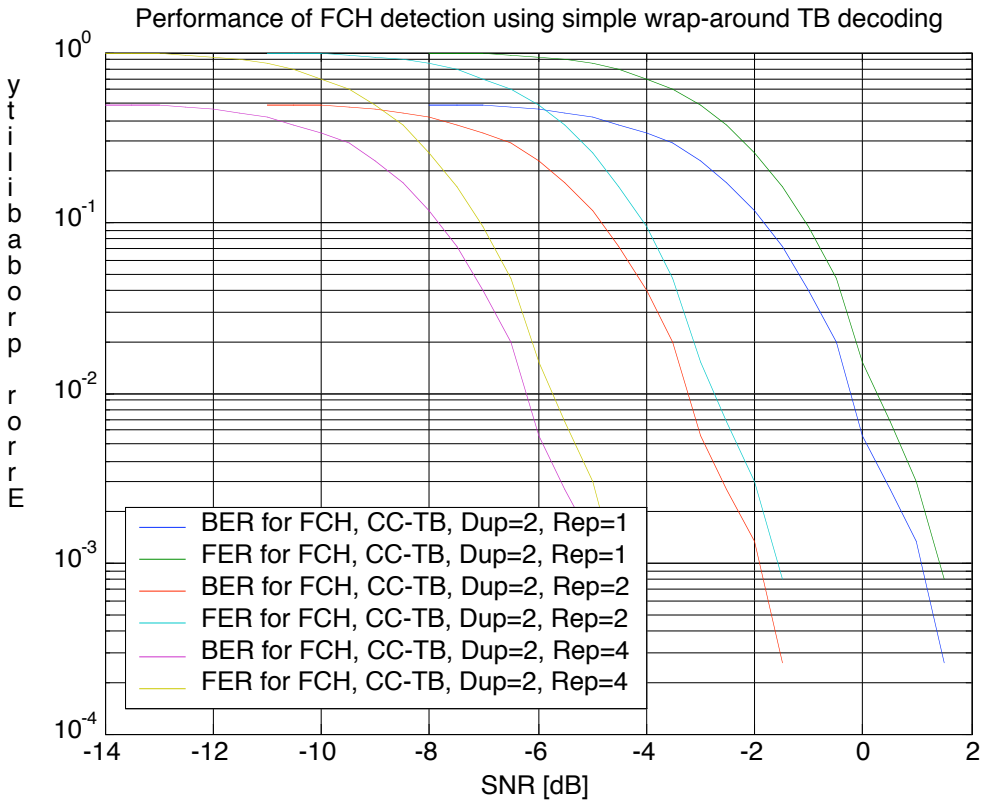
8.4.4.3 DL Frame Prefix

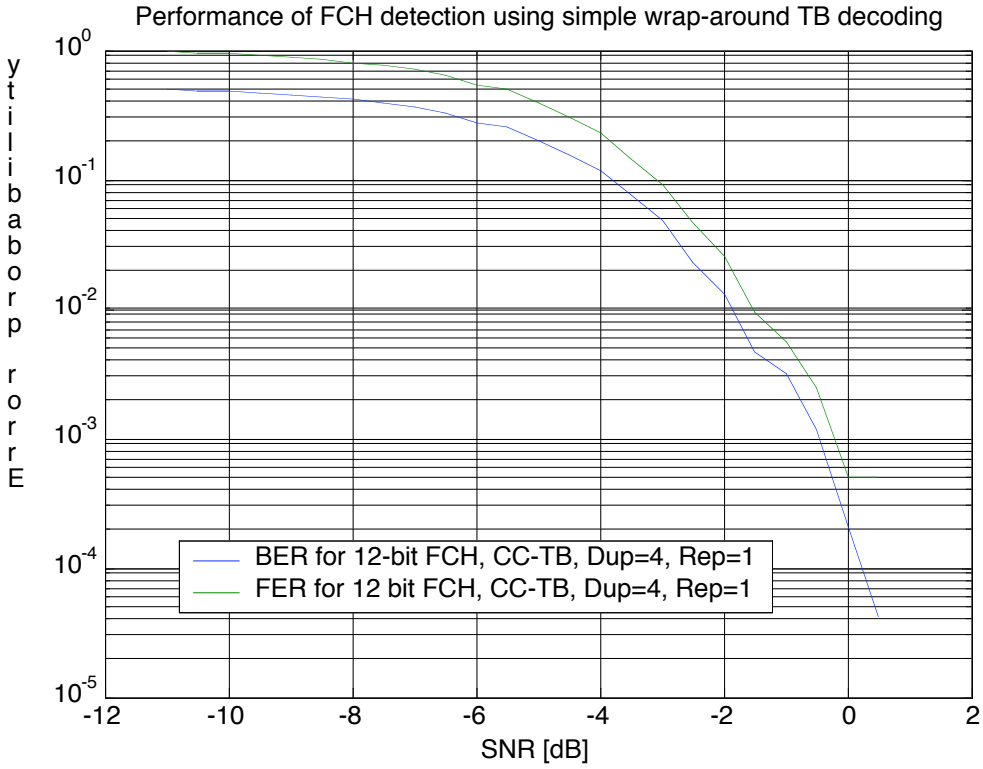
[Add the following lines to table 266b]:

FFT size	Subchannel group #	Subchannel Range
128	0	0
	1	-
	2	1
	3	-
	4	2

	5	-

5. Simulation results





6. References

[1] IEEE P802.16-REVe/D4-2004 Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands