Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>	
Title	**Proposed 802.16m DL Control Channel Scheme to Use More Subcarriers in Guard Band**	
Date Submitted	**2008-03-14**	
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Re:	IEEE 802.16m-08/005, "Call for Contributions on Project 802.16m System Description Document (SDD)" for the following topic: ● Downlink Control Structure	
Abstract	This contribution describes a method to use subcarriers in guard band to enhance resource utilization in frequency overlay mode	
Purpose	To be discussed and adopted by TGm for use in 802.16m SDD	
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Proposed 802.16m DL Control Channel Scheme to Use More Subcarriers in Guard Band

1. Introduction

This contribution describes a method to use more subcarriers in guard band by setting frequency separation between two adjacent FAs as multiple of subcarrier spacing. In this case, subcarriers in guard band can be used as data subcarriers without causing ICI between two adjacent FAs.

2. Using subcarriers in guard band

In current IEEE 802.16e system, the center frequency of each FA shall be located on multiple of 250kHz. Thus the separation of any 2 FAs will be also multiple of 250kHz (e.g. 10MHz center freq. separation for 10MHz channel bandwidth). In this case, sampling frequency is 11.2MHz and thus the subcarrier spacing is 10.9375kHz. Because 10MHz is not multiple of the subcarrier spacing, using subcarriers in guard band will cause severe ICI problem. Figure 1 shows an example of ICI problem caused by using subcarriers in guard band bwtween FA1 and FA2. On the other hand, if the frequency raster is modified to ensure the separation of center frequency is multiple of subcarrier spacing, then subcarriers in guard band can be used for data transmission.

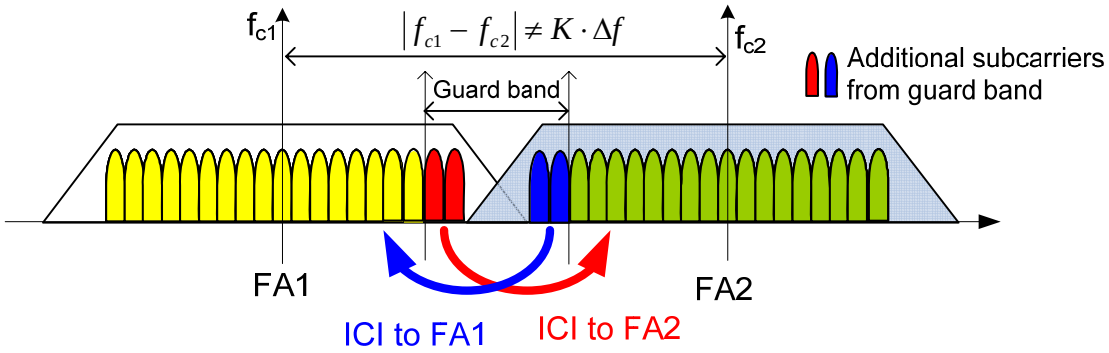

Figure 1. ICI problem when using subcarriers in guard band

3. Proposed Solution

ICI can be avoided by setting the separation of center frequency between two adjacent FAs as multiple of subcarrier spacing as depicted in Figure 2.

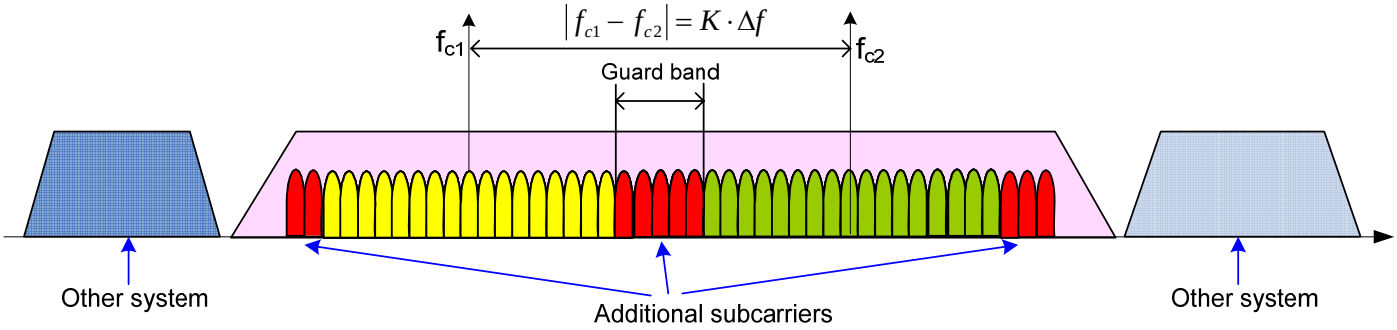

Figure 2. Using additional subcarriers in guard band

For 11.2MHz sampling frequency case, suggested frequency raster is 175kHz which is 16 times of subcarrier spacing (16 x 10.9375kHz = 175kHz). In this case, the center frequency spacing can be set to 10.15MHz (175kHz x 58) which is a multiple of subcarrier spacing. Figure 3 shows an example of this case. The number of subcarriers except guard band and DC subcarrier is 864, then the number of additional subcarriers that can be used in the guard band between FA1 and FA2 is up to 63.

$$10.15\text{MHz} / 10.9375\text{kHz} - (864 + 1) = 63 \quad (1)$$

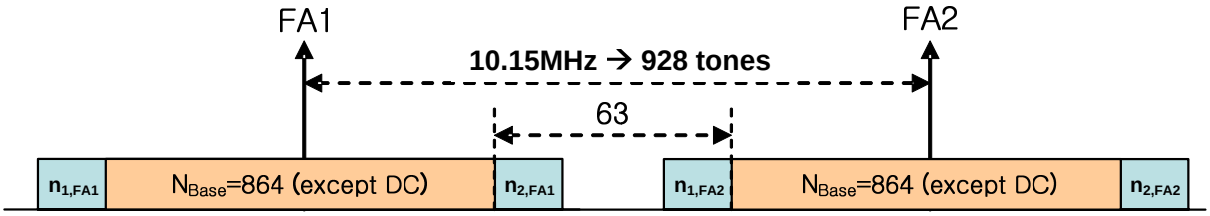

Figure 3. Using additional subcarriers in guard band (1024 FFT)

Also, Figure 4 and Figure 5 show another example for 512 and 2048 FFT case respectively.

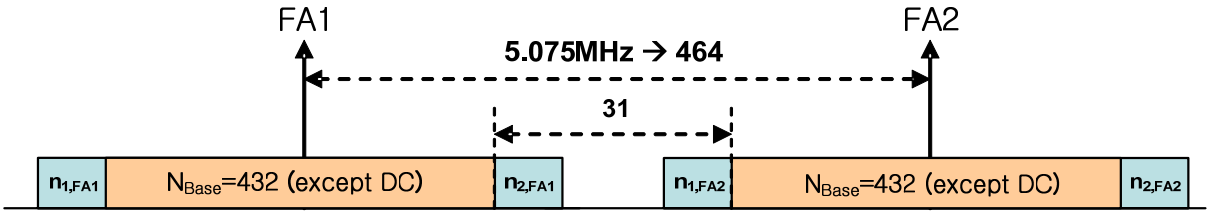

Figure 4. Using additional subcarriers in guard band (512 FFT)

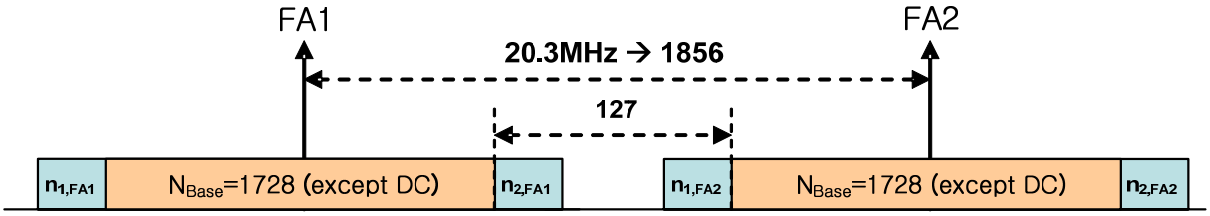

Figure 5. Using additional subcarriers in guard band (2048 FFT)

3.1 Initial synchronization

For initial network entry, each MS has to acquire initial center frequency synchronization. Because the location of center frequency is multiple of 175kHz, MS tries to find preamble on frequency with multiple of 175kHz. Further, superframe header which includes SCH and/or BCH shall be designed so as to MSs can receive control channels transmitted in superframe header without knowing the amount of additional subcarriers used in guard band.

3.2 Initial network entry and system information acquisition

After initial synchronization, MS tries to acquire the number of subcarriers used in data region symbols from

BCH which is transmitted in superframe header. BS informs MSs with n_1 and n_2 which is the number of additional subcarriers used in left guard band and right guard band respectively.

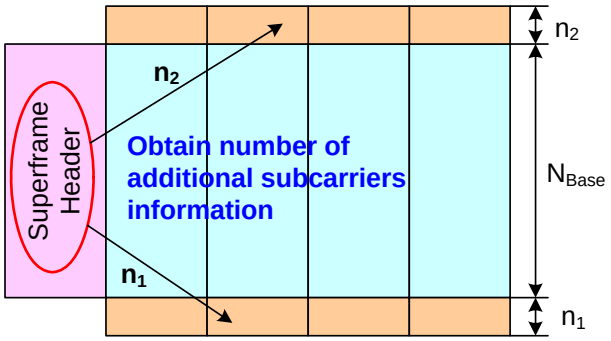

Figure 5. Used subcarrier information acquisition from BCH

At once MS obtains the number of subcarriers used in data region, then MS can perform permutation and receive control information and data bursts transmitted in data region. Permutation is performed based on the number of total subcarriers ($=n_1+n_2+N_{Base}$) used in data region as depicted in Figure 6.

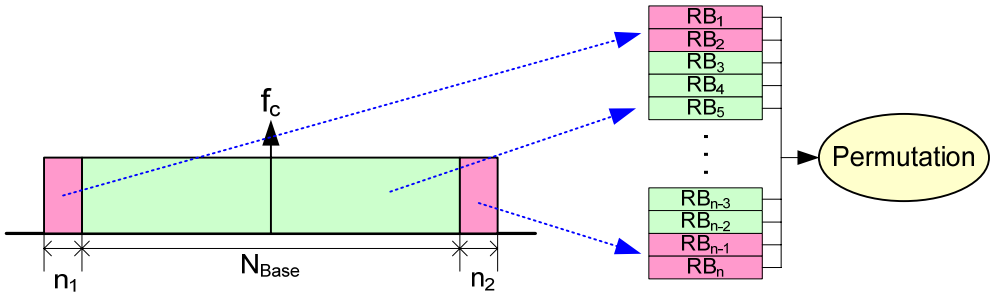

Figure 6. Using additional subcarriers in guard band

After BCH acquisition, MS can try to initiate network entry on the synchronized FA.

4. Proposed Text

[Add the following sub-section in DL control channel sub-section]

xx.1 Superframe header design

If the separation of center frequency between two adjacent FA is multiple of subcarrier spacing, the subcarriers once reserved for guard band can be used for the data transmission. The superframe header shall carry the information about the number of subcarriers used in left guard band, which is denoted as n_1, and the number of subcarriers used in right guard band, which is denoted as n_2. Then the total number of data subcarriers used in data region symbol is $N_{Total} = N_{Base} + n_1 + n_2$ where N_{Base} denotes the number of data subcarriers without using the guard band subcarriers. Further, SCH and BCH in superframe header shall be designed based only on N_{Base}.