
Project	IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>	
Title	Optional midamble for OFDMA mode	
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Re:	Call for Comments: Editor's Draft Consolidation of IEEE 802.16/802.16a/802.16c – (802.16d-03/13)	
Abstract	The document suggests addition of an optional midamble to the OFDMA mode of the IEEE802.16a to enhance performance in broadband channels in a mobile environment.	
Purpose	To adopt these enhancements as additions to the OFDMA mode	
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Optional midamble for OFDMA mode

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General

The following document proposes the addition of an optional midamble to the OFDAM mode of IEEE802.16a. The proposed midamble can enhance channel estimation in broadband channels (e.g. 10MHz and above), where relying on pilot tones alone may not be sufficient. The midamble is optional in the sense that a BS may implement it, and a SS may take advantage of its presence, but the SS is required to recognize the presence of the midamble and react accordingly.

Specific text changes:

[On page 478, line 38 in table 229, delete the line about ‘Compressed_MAP_Used’ and insert instead the following:]

Midambels Used	1 bit	0 – No midambles in downlink 1 – Optional midambles used in downlink
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[On page 477, line 59 in table 229, insert the following:]

8.5.4.3 PMP frame structure with optional midambles

The basic PMP frame structure described in section 8.5.4.2 can be enhanced for use in broadband channels by use of optional midambles. The midambles are half OFDMA symbol long, and use the same GI as the rest of the OFDMA symbols. The midamble duration is $T_m = (T_s - T_g)/2 + T_g$. The midambles are inserted every third OFDMA symbol not counting the frame preamble.

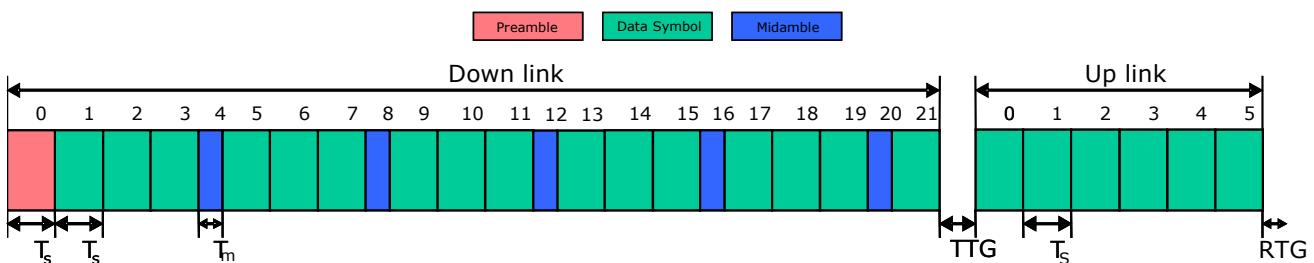


Figure 1: PMP frame structure example with the optional midamble - TDD

The midambles presence or is indicated in the DL_FRAME_PREFIX. The preamble is optional in a sense that a BS may support the optional midambels, and an SS may take advantage of its presence, but an SS shall recognize the presence of the midamble and interpret the downlink structure accordingly.

[End of text to be inserted]

[On page 538, line 65, insert the following:]

8.5.9.4.4 Pilot modulation for optional midambles

The optional midambles which may be transmitted every three OFDMA symbols in the downlink are half the length of a regular OFDMA symbol, but include a full CP. Figure 2 shows how the midamble is generated.

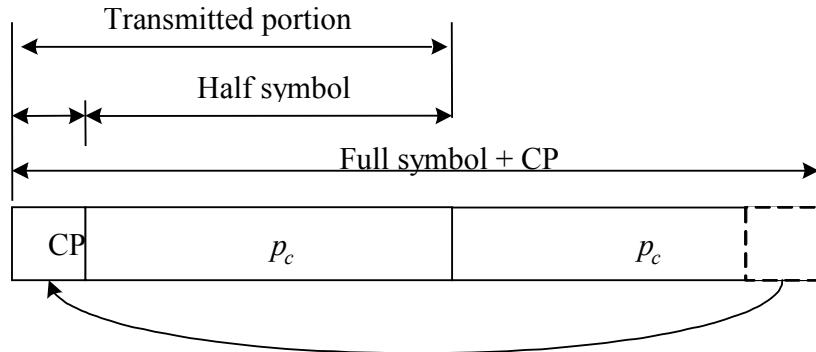


Figure 2: Midamble generation in time domain

There are two types of midambles, the first type uses every second sub-carrier and is preferred for FUSC deployments, and the second type uses every sixth sub-carrier, and is preferred for PUSC deployments.

The midamble preferred for FUSC has one of 97 distinct patterns and the neighboring cells or sectors shall have different patterns so that the SS can distinguish their cell and sector from others. The midamble is generated from the following frequency-domain sequence.

$$P_{c,s}[k] = \begin{cases} \sqrt{2}(1 - 2q_{c,s}[m]), & k = 2m - 776, m = 0, 1, \dots, 387 \\ \sqrt{2}(1 - 2q_{c,s}[m-1]), & k = 2m - 776, m = 389, 390, \dots, 776 \\ 0, & \text{otherwise} \end{cases} \quad (1.)$$

$$c = 0, 1, 2, \dots, 96, s = 0, 1, 2, \dots, 7, k = -1024, -1023, \dots, 1023.$$

c is the cell number from the set [0 ~ 96] and s is a Walsh number.

If $P_{c,s}[k]$ is IFFT-processed, it results in a pattern repeating itself once in the time-domain. In Eq. (10), $\sqrt{2}$ is multiplied so that the midamble has the same average power level as that of the data OFDMA symbols and $q_{c,s}[m]$ is defined as follows.

$$q_{c,s}[m] = w_{m \bmod 8}^s \oplus p_{(16c+m) \bmod 2047}, \quad m = 0, 1, 2, \dots, 775 \quad (2.)$$

where \oplus denotes the exclusive-OR operator, $w_n^s \in \{0,1\}$ is the n-th value of the s-th codeword in the 8-ary Walsh code set, and p_n is the n-th value of the PN sequence generated from the PRBS shown in Figure 3. The generator polynomial of the PRBS is $X^{11} + X^9 + 1$.

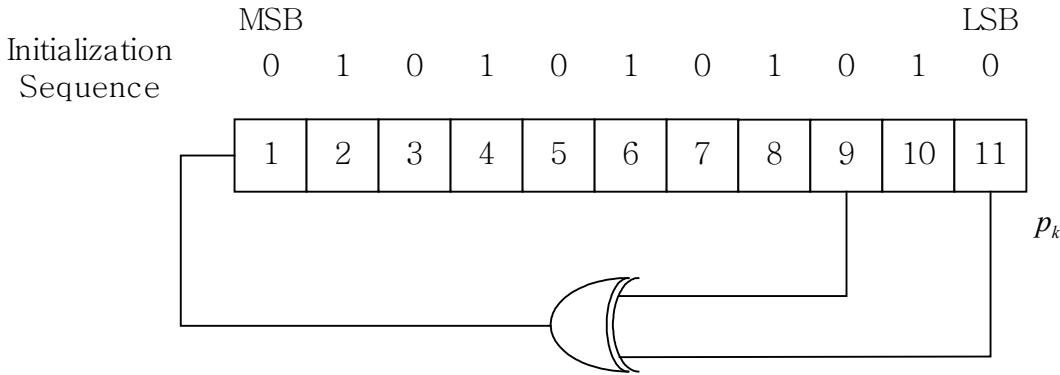


Figure 3: PRBS structure for preamble and pilot symbol generation

The initialization vector of the PRBS for the preamble modulation is [01010101010].

The midambles preferred for PUSC are defined by Table 1. When using the midambles in Table 1, the BS shall transmit the midamble indexed $M_{(j+n) \bmod 114}$, where j is the index of the frame preamble indicated in table xxx and n is the midamble index, where the first midamble in the frame is index 0.

The midamble is constructed according to the formula $P_c(6 \cdot k + 4 \cdot Segment \bmod 6) = Y(k)$, where:

P_c specifies all the used carriers allocated to the specific midamble, k is a running index 0..287, and the *Segment* variable is the same as the one of the frame preamble defined in table xxx.

Index	Series to modulate $Y(k)$	PAPR
1.	<pre>--+++++-----+----+-----+-----+-----+-----+-----+-----+-----+-----+ ++++++-----+----+-----+-----+-----+-----+-----+-----+-----+-----+ -----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+ -----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+ -----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+ -----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+ -----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+</pre>	3.74

37.	-++++++-++-+----+-----+-----+-----+-----+ -+-+-+--+----+-----+-----+-----+-----+ +----+--+----+-----+-----+-----+-----+ +---+--+----+-----+-----+-----+-----+ +---+--+----+-----+-----+-----+-----+ -+++----+-----+-----+-----+-----+ +++++	4.07
38.	-++++++-++-+----+-----+-----+-----+-----+ -+-+-+--+----+-----+-----+-----+-----+ +----+--+----+-----+-----+-----+-----+ +---+--+----+-----+-----+-----+-----+ +---+--+----+-----+-----+-----+-----+ -+++----+-----+-----+-----+-----+ +++++	4.07
39.	-+-+---+---+---+---+ +---+---+---+---+ +---+---+---+---+ +---+---+---+---+ +---+---+---+---+ +---+---+---+---+ +---+---+---+---+	4.22
40.	+-----+-----+-----+-----+ +-----+-----+-----+-----+ -+-----+-----+-----+-----+ +-----+-----+-----+-----+ +-----+-----+-----+-----+ -+-----+-----+-----+-----+ +---	4.09
41.	+-----+-----+-----+-----+ +-----+-----+-----+-----+ -+-----+-----+-----+-----+ +-----+-----+-----+-----+ +-----+-----+-----+-----+ -+-----+-----+-----+-----+ +---	4.09
42.	-+-----+-----+-----+-----+ -+-----+-----+-----+-----+ -+-----+-----+-----+-----+ -+-----+-----+-----+-----+ -+-----+-----+-----+-----+ +-----+-----+-----+-----+ +---	4.06
43.	+-----+-----+-----+-----+ +-----+-----+-----+-----+ -+-----+-----+-----+-----+ +-----+-----+-----+-----+ +-----+-----+-----+-----+ +-----+-----+-----+-----+ +---	4.14

44.	+-+-+---+----+-----+----+-----+---+--+	4.02
45.	-+--+----+-----+-----+-----+---+--+	4.39
46.	+--+----+-----+-----+-----+-----+--+	4.02
47.	-+--+----+-----+-----+-----+-----+--+	4.17
48.	-+--+----+-----+-----+-----+-----+--+	4.17
49.	-+--+----+-----+-----+-----+-----+--+	4.17
50.	+--+----+-----+-----+-----+-----+--+	4.04

51.	-+-+-+----+---+-----+-----+-----+-----+ -+-+-+----+---+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+	4.14
52.	+-----+-----+-----+-----+-----+-----+ +++++-+----+-----+-----+-----+-----+ +++++-+----+-----+-----+-----+-----+ ++-+----+-----+-----+-----+-----+-----+ --+-+----+-----+-----+-----+-----+-----+ -+++++-+----+-----+-----+-----+-----+ +---+----+---	4.06
53.	-+-----+-----+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ +---+----+---+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ +---+----+---	4.04
54.	+-----+-----+-----+-----+-----+-----+ -----+-----+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ +++++-+----+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ -+---+----+---	4.14
55.	+-----+-----+-----+-----+-----+-----+ -----+-----+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ ++-+----+---+-----+-----+-----+-----+ --+-+----+---+-----+-----+-----+-----+ -+---+----+---	4.18
56.	+-----+-----+-----+-----+-----+-----+ +++++-+----+-----+-----+-----+-----+ -+-----+-----+-----+-----+-----+-----+ +-----+-----+-----+-----+-----+-----+ +-----+-----+-----+-----+-----+-----+ +-----+-----+-----+-----+-----+-----+ +---+----+---	4.11
57.	------+-----+-----+-----+-----+-----+ -+---+----+-----+-----+-----+-----+ +++++-+----+-----+-----+-----+-----+ -+-----+-----+-----+-----+-----+-----+ -+-----+-----+-----+-----+-----+-----+ +-----+-----+-----+-----+-----+-----+ +---+----+---	4.14

79.	+++++---+---++-+---+++-+--+--++---+ ++-++-++-++-++-+----++-+----+---++-+ ++-++-++-+----+---+---++-+--+--++-+ ++-++-++-++-+----+---++-+--+--++-+ ++-++-++-+----+---+---++-+----+---++-+ ++-++-++-+----+---+---++-+----+---++-+ -++-	4.06
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81.	-+---+---+---+---+---+---+---+---+ ++-+---+---+---+---+---+---+---+---+ +---+---+---+---+---+---+---+---+---+ ++-+---+---+---+---+---+---+---+---+ +---+---+---+---+---+---+---+---+---+ ++-+---+---+---+---+---+---+---+---+ +---+---+---+---+---+---+---+---+ +---	4.11
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Table 1: Preferred midamble series for PUSC definition

For table 1, in column specifying the series of W_k , a + sign indicates a value of +1 and the – sign indicates a value of -1 for the specific pilot, furthermore the CellId parameter is used for FUSC, while for PUSC the CellId is constant and equals 0.

[End of text to be inserted]