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Project **IEEE 802.16 Broadband Wireless Access Working Group** <<http://ieee802.org/16>>

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Title **128 and 256 FFT Sizes for OFDMA PHY**

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Re: Working Group Review of P802.16e/D2

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Abstract

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Purpose To propose enhancements to the OFDMA PHY in P802.16e/D2 draft for better performance in narrow channel bandwidths.

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2 **1 Introduction**

3 In this contribution we propose enhancements to the WirelessMAN OFDMA PHY, so that it can perform more optimally in  
 4 narrow channel bandwidths of smaller than 5 MHz while keeping the sub-carrier spacing fixed in line with the concept of  
 5 Scalable OFDMA option in P802.16e/D2. The following are some of the parameters that are required to meet the  
 6 requirements from service providers. The contribution covers expansion of Scalable FFT size set to include 256 and 128 for  
 7 DL FUSC and PUSC sub-channelization and UL sub-channelization formats.

8 **2 Bandwidth**

9 For service providers who would like to deploy a high speed public cellular network, the system bandwidths are limited to 1.25,  
 10 2.5, 5, and 10 MHz for licensed bands and 10 and 20MHz for unlicensed bands.

11 **3 Sampling Frequency**

12 According to the allowed bandwidth, the sampling frequency needs to be the same as specified in P80216-REVd\_D4.

13 **4 FFT Size and CP duration**

14 In order to support full coverage and full mobility with low overhead for CP insertion for smaller bandwidths, the option for  
 15 FFT sizes of 128 and 256 should be also included, i.e., 128-FFT for 1.25 MHz BW and 256-FFT for 2.5 MHz BW to be added  
 16 to the existing set of options, that is 512-FFT for 5 MHz, 1024-FFT for 10 MHz BW, and 2048-FFT for 20 MHz BW. Although  
 17 the CP duration can be as large as ¼ of an OFDMA symbol duration, but by choosing CP value of 1/8, the maximum  
 18 multipath delay of 12.8 us can be supported while the corresponding overhead is limited to 10% for all bandwidth  
 19 configurations.

20 **5 Frame Length**

21 Frame length is from 2msec to 20msec with identical frame structure for various channel bandwidths in licensed and licensed  
 22 exempt operation.

23 **6 Proposed Text Changes**

24  
 25 *[Apply the following changes to Tables 272a and 272c ]*  
 26

27 **Table 272a— 2048-FFT OFDMA downlink carrier allocations**

Parameter	Value	Comments
Number of DC Subcarriers	1	Index 1024
Number of Guard Subcarriers, Left	172	
Number of Guard Subcarriers, Right	173	
Number of Used Subcarriers (Nused)	1703	Number of all subcarriers used within a symbol, including all possible allocated pilots and the DC carrier.
Pilots		
VariableSet #0	24	0,72,144,216,288,360,432,504,576,648,720,792,864,936,1008,1080,1152,1224,1296,1368,1440,1512,1584,1656
ConstantSet #0	4	39,645,1017,1407
VariableSet #1	24	36,108,180,252,324,396,468,540,612,684,756,828,900,972,1044,1116,1188,1260,1332,1404,1476,1548,1620,1692
ConstantSet #1	4	261,,651,1143,1419
VariableSet #2	234	48,120,192,264,336,408,480,552,624,696,768,840,912,984,1056,1128,1200,1272,1344,1416,1488,1560,1632
ConstantSet #2	4	330,726,1155,1461
VariableSet #3	24	12,84,156,228,300,372,444,516,588,660,732,804,876,948,1020,1092,1164,1236,1308,1380,1452,1524,1596,1668
ConstantSet #3	4	342,849,1158,1530
VariableSet #4	24	24,96,168,240,312,384,456,528,600,672,744,816,888,960,1032,1104,1176,1248,1320,1392,1464,1536,1608,1680

ConstantSet #4	4	351,855,1185,1545
VariableSet #5	23	60,132,204,276,348,420,492,564,636,,708,780,852, 924,996,1068,1140,1212,1284,1356,1428,1500, 1572,1644
ConstantSet #5	4	522,918,1206,1701
Number of data subcarriers	1536	
Number of data subcarriers per subchannel	48	
Number of Subchannels	32	
PermutationBase		3, 18, 2, 8, 16, 10, 11, 15, 26, 22, 6, 9, 27, 20, 25, 1, 29, 7, 21, 5, 28, 31, 23, 17, 4, 24, 0, 13, 12, 19, 14, 30

**Table 272c— 512-FFT OFDMA downlink carrier allocations**

<u>Parameter</u>	<u>Value</u>	<u>Comments</u>
<u>Number of DC Subcarriers</u>	<u>1</u>	<u>Index 256</u>
<u>Number of Guard Subcarriers, Left</u>	<u>43</u>	
<u>Number of Guard Subcarriers, Right</u>	<u>43</u>	
<u>Number of Used Subcarriers (Nused)</u>	<u>426</u>	<u>Number of all subcarriers used within a symbol, including all possible allocated pilots and the DC carrier.</u>
<u>Pilots</u>		
<u>VariableSet #0</u>	<u>6</u>	<u>0,72,144,216,288,360</u>
<u>ConstantSet #0</u>	<u>1</u>	<u>39</u>
<u>VariableSet #1</u>	<u>6</u>	<u>36,108,180,252,324,396</u>
<u>ConstantSet #1</u>	<u>1</u>	<u>261</u>
<u>VariableSet #2</u>	<u>6</u>	<u>48,120,192,264,336,408</u>
<u>ConstantSet #2</u>	<u>1</u>	<u>330</u>
<u>VariableSet #3</u>	<u>6</u>	<u>12,84,156,228,300,372</u>
<u>ConstantSet #3</u>	<u>1</u>	<u>342</u>
<u>VariableSet #4</u>	<u>6</u>	<u>24,96,168,240,312,384</u>
<u>ConstantSet #4</u>	<u>1</u>	<u>351</u>
<u>VariableSet #5</u>	<u>56</u>	<u>60,132,204,276,348</u>
<u>ConstantSet #5</u>	<u>1</u>	<u>420</u>
<u>Number of data subcarriers</u>	<u>384</u>	
<u>Number of data subcarriers per subchannel</u>	<u>48</u>	
<u>Number of Subchannels</u>	<u>8</u>	
<u>PermutationBase</u>		<u>7.4.0.2.1.5.3.6</u>

[Add the following tables in section 8.4.6.1.2 after Table 272c and rename Tables 272d-f to 272f-h]

**Table 272d— 256-FFT OFDMA downlink carrier allocations**

<u>Parameter</u>	<u>Value</u>	<u>Comments</u>
<u>Number of DC Subcarriers</u>	<u>1</u>	<u>Index 128</u>
<u>Number of Guard Subcarriers, Left</u>	<u>21</u>	
<u>Number of Guard Subcarriers, Right</u>	<u>21</u>	
<u>Number of Used Subcarriers (Nused)</u>	<u>214</u>	<u>Number of all subcarriers used within a symbol, including all possible allocated pilots and the DC carrier.</u>
<u>Pilots</u>		
<u>VariableSet #0</u>	<u>2</u>	<u>0,72</u>
<u>ConstantSet #0</u>	<u>1</u>	<u>39</u>
<u>VariableSet #1</u>	<u>3</u>	<u>36,108,180,</u>
<u>ConstantSet #1</u>	<u>1</u>	<u>261</u>
<u>VariableSet #2</u>	<u>2</u>	<u>48,120</u>
<u>ConstantSet #2</u>	<u>1</u>	<u>330</u>
<u>VariableSet #3</u>	<u>3</u>	<u>12,84,156,</u>

<u>ConstantSet #3</u>	<u>1</u>	<u>342</u>
<u>VariableSet #4</u>	<u>3</u>	<u>24,96,168,</u>
<u>ConstantSet #4</u>	<u>1</u>	<u>351</u>
<u>VariableSet #5</u>	<u>2</u>	<u>60,132,</u>
<u>ConstantSet #5</u>	<u>1</u>	<u>420</u>
<u>Number of data subcarriers</u>	<u>192</u>	
<u>Number of data subcarriers per subchannel</u>	<u>48</u>	
<u>Number of Subchannels</u>	<u>4</u>	
<u>PermutationBase</u>		<u>TBD</u>

**Table 272e— 128-FFT OFDMA downlink carrier allocations**

<u>Parameter</u>	<u>Value</u>	<u>Comments</u>
<u>Number of DC Subcarriers</u>	<u>1</u>	<u>Index 64</u>
<u>Number of Guard Subcarriers, Left</u>	<u>10</u>	
<u>Number of Guard Subcarriers, Right</u>	<u>10</u>	
<u>Number of Used Subcarriers (Nused)</u>	<u>108</u>	<u>Number of all subcarriers used within a symbol, including all possible allocated pilots and the DC carrier.</u>
<u>Pilots (TBD)</u>		
<u>VariableSet #0</u>	<u>1</u>	<u>0</u>
<u>ConstantSet #0</u>	<u>1</u>	<u>39</u>
<u>VariableSet #1</u>	<u>1</u>	<u>36</u>
<u>ConstantSet #1</u>	<u>1</u>	<u>261</u>
<u>VariableSet #2</u>	<u>1</u>	<u>48</u>
<u>ConstantSet #2</u>	<u>1</u>	<u>330</u>
<u>VariableSet #3</u>	<u>1</u>	<u>12</u>
<u>ConstantSet #3</u>	<u>1</u>	<u>342</u>
<u>VariableSet #4</u>	<u>1</u>	<u>24</u>
<u>ConstantSet #4</u>	<u>1</u>	<u>351</u>
<u>VariableSet #5</u>	<u>1</u>	<u>60</u>
<u>ConstantSet #5</u>	<u>1</u>	<u>420</u>
<u>Number of data subcarriers</u>	<u>96</u>	
<u>Number of data subcarriers per subchannel</u>	<u>48</u>	
<u>Number of Subchannels</u>	<u>2</u>	
<u>PermutationBase</u>		<u>TBD</u>

[Add the following tables in section 8.4.6.1.2 after renamed Table 272h as suggested above]

**Table 272i— 256-FFT OFDMA downlink carrier allocations - PUSC**

<u>Parameter</u>	<u>Value</u>	<u>Comments</u>
<u>Number of DC Subcarriers</u>	<u>1</u>	<u>index 128</u>
<u>Number of Guard Subcarriers, Left</u>	<u>23</u>	
<u>Number of Guard Subcarriers, Right</u>	<u>24</u>	
<u>Number of Used Subcarriers (Nused) including all possible allocated pilots and the DC carrier.</u>	<u>209</u>	<u>Number of all subcarriers used within a symbol</u>
<u>renumbering sequence</u>	<u>TBD</u>	<u>used to renumber clusters before allocation to subchannels:</u>
<u>Number of carriers per cluster</u>	<u>13</u>	<u>Number of all subcarriers used within a symbol.</u>

<u>Number of clusters</u>	<u>16</u>	
<u>Number of carries per subchannel</u>	<u>22</u>	
<u>Number of subchannels</u>	<u>8</u>	
<u>PermutationBase6 (for 6 subchannels)</u>	<u>TBD</u>	
<u>PermutationBase4 (for 4 subchannels)</u>	<u>TBD</u>	

**Table 272j— 128-FFT OFDMA downlink carrier allocations - PUSC**

<u>Parameter</u>	<u>Value</u>	<u>Comments</u>
<u>Number of DC Subcarriers</u>	<u>1</u>	<u>index 64</u>
<u>Number of Guard Subcarriers, Left</u>	<u>11</u>	
<u>Number of Guard Subcarriers, Right</u>	<u>12</u>	
<u>Number of Used Subcarriers (Nused) including all possible allocated pilots and the DC carrier.</u>	<u>105</u>	<u>Number of all subcarriers used within a symbol</u>
<u>renumbering sequence</u>	<u>TBD</u>	<u>used to renumber clusters before allocation to subchannels:</u>
<u>Number of carriers per cluster</u>	<u>13</u>	<u>Number of all subcarriers used within a symbol,</u>
<u>Number of clusters</u>	<u>8</u>	
<u>Number of carries per subchannel</u>	<u>22</u>	
<u>Number of subchannels</u>	<u>4</u>	
<u>PermutationBase6 (for 6 subchannels)</u>	<u>TBD</u>	
<u>PermutationBase4 (for 4 subchannels)</u>	<u>TBD</u>	

[Add the following tables after Table 247b]

**Table 247c—256-FFT OFDMA uplink subcarrier allocations**

<u>Parameter</u>	<u>Value</u>	<u>Comments</u>
<u>Number of DC Subcarriers</u>	<u>1</u>	<u>index 128</u>
<u>Number of Guard Subcarriers, Left</u>	<u>31</u>	
<u>Number of Guard Subcarriers, Right</u>	<u>32</u>	
<u>Number of Used Subcarriers (Nused) including all possible allocated pilots and the DC carrier.</u>	<u>193</u>	<u>Number of all subcarriers used within a symbol</u>
<u>PermutationBase0</u>	<u>TBD</u>	<u>used to allocate tiles to subchannels</u>
<u>Number of carriers per tile</u>	<u>4</u>	<u>Number of all subcarriers used within a tile</u>
<u>Number of tiles</u>	<u>48</u>	
<u>Number of tiles per subchannel</u>	<u>6</u>	
<u>Number of subchannels</u>	<u>8</u>	

**Table 247d—128-FFT OFDMA uplink subcarrier allocations**

<u>Parameter</u>	<u>Value</u>	<u>Comments</u>
<u>Number of DC Subcarriers</u>	<u>1</u>	<u>index 64</u>
<u>Number of Guard Subcarriers, Left</u>	<u>15</u>	
<u>Number of Guard Subcarriers, Right</u>	<u>16</u>	
<u>Number of Used Subcarriers (Nused) including all possible allocated pilots and the DC carrier.</u>	<u>97</u>	<u>Number of all subcarriers used within a symbol</u>
<u>PermutationBase0</u>	<u>TBD</u>	<u>used to allocate tiles</u>

		<u>to subchannels</u>
<u>Number of carriers per tile</u>	<u>4</u>	<u>Number of all subcarriers used within a tile</u>
<u>Number of tiles</u>	<u>30</u>	
<u>Number of tiles per subchannel</u>	<u>6</u>	
<u>Number of subchannels</u>	<u>4</u>	

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