

<b>Project</b>	IEEE 802.16 Broadband Wireless Access Working Group < <a href="http://ieee802.org/16">http://ieee802.org/16</a> >	
<b>Title</b>	<b>Rate=5/6 LDPC Coding for OFDMA PHY</b>	
<b>Date Submitted</b>	2005-07-06	
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<b>Re:</b>	<b>Call for comments, Sponsor Ballot on IEEE802.16e/D9 document</b>	
<b>Abstract</b>	<b>In this contribution, rate=5/6 LDPC codes are provided to complete LDPC in IEEE802.16e.</b>	
<b>Purpose</b>	<b>To incorporate the text changes proposed in this contribution into the 802.16e/D10 draft.</b>	
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# **Rate=5/6 LDPC Coding for OFDMA PHY**

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## **Overview**

We propose that rate 5/6 codes be added to IEEE802.16-REVe/D10 so that the code rates for LDPC are consistent with those for CC and CTC.

As we all know, code rate, codeword length and degree distribution decide the performance of LDPC codes. When Message Passing algorithm is used, the short cycles in the bipartite of LDPC codes will obviously degrade the performance of the LDPC codes, especially when SNR is high. Girth was defined as the length of the shortest cycle of the bipartite of LDPC codes, and it has become a criterion on the performance of LDPC codes.

In our new design scheme, we can ensure that our design is uniform with “IEEE C802.16e-05/0066r3”. 24-column base matrix has been adopted, and dual-diagonal structure corresponding to parity check bits also has been used. In the base model matrix of rate 5/6 codes, the first column of the part corresponding to parity bits has adopted “a-0-a” structure.

We have several good reasons to add rate 5/6 codes to 16e as following:

1. Additional hardware complexity is small because the size of base model matrix is 4\*24.
2. The best way to improve spectral efficiency. Through simulation, we find that it is a more efficient way to improve spectral efficiency by increasing code rate than by increasing modulation dimension.
3. The maximum capacity of OFDMA PHY can be enhanced.
4. Rate 5/6 codes can help to form a complete LDPC scheme. CC and CTC have rate 5/6 codes, thus LDPC also should have rate 5/6 codes.
5. High rate codes have been widely used in other communication system, such as Flash-OFDM, DVB, Optical communication etc. Because of the perfect performance of LDPC codes, we should have better reason to use available high rate codes.

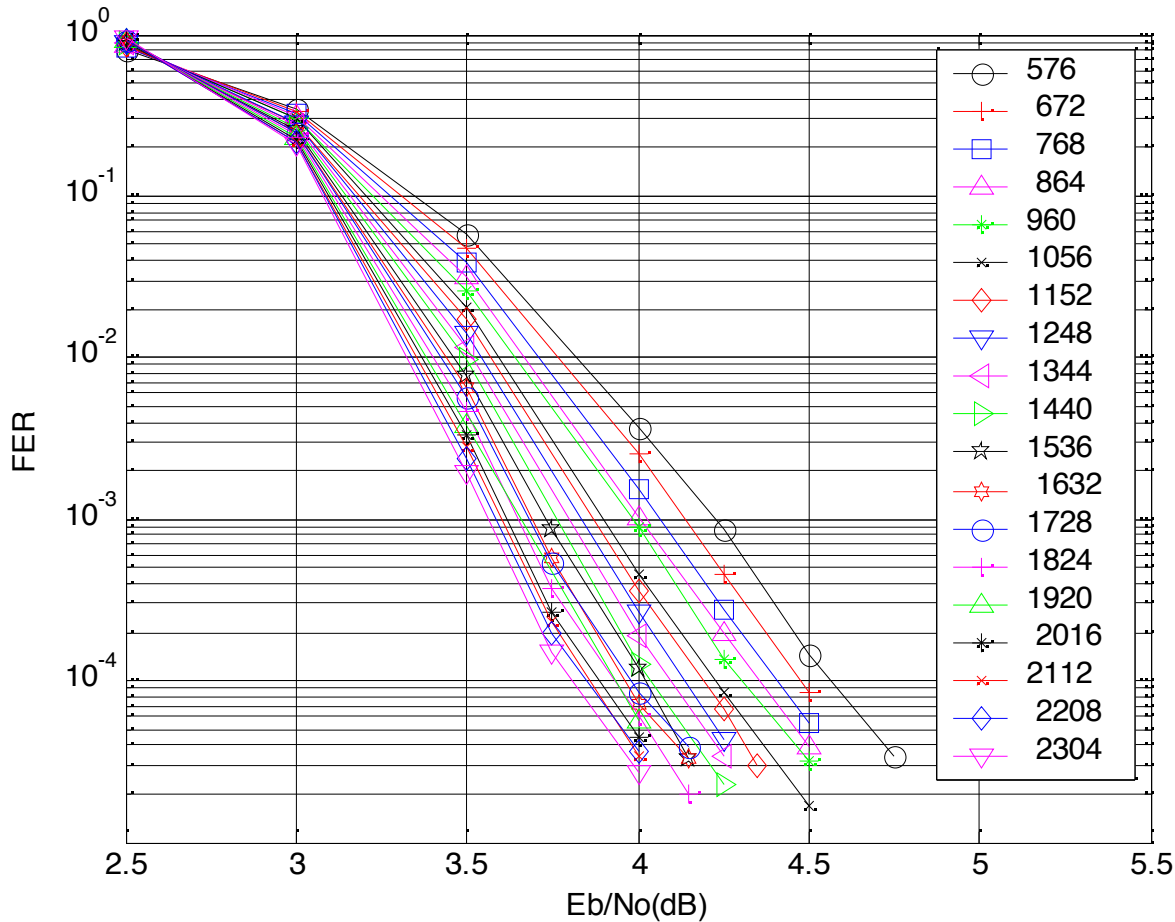
## **Features**

- Simple encoding and decoding
- Less average iteration numbers
- Good performance
- Eliminate error floor

## **Simulation Results**

Simulation results for ZTE high girth codes of the rate 5/6 code families are shown in Figure 1. For the rate, code sizes considered are all 576-2304. The simulation conditions are: AWGN channel, BPSK modulation, max

iterations times 50, using generic floating-point belief propagation. From the simulation results we can find that our codes overcome the “error floor” phenomenon, and the BER curve of them will descend more steeply. When SNR is high, our high girth method obviously obtained an improved performance. The expansion factor  $z$  ranges from 24 to 96, as shown in Figures 1. The block size and the expansion factor are related by  $n = 24 * z$ .



**Recommended Text Changes:**

*[Add/Modify the text in 802.16e\_D9 as follows, adjusting the numbering as required:]*

**In the “8.4.9.2.5.1 Code Description”**

There is a sentence as following: To support 5/6 codes, we suggest that a sentence should have some changes as following:

For code rates 1/2, 3/4 A and B code, **and 2/3 B code, and 5/6 code**, the shift sizes  $\{p(f, i, j)\}$  for a code size corresponding to expansion factor  $z_f$  are derived from  $\{p(i, j)\}$  by scaling  $p(i, j)$  proportionally

$$p(f, i, j) = \begin{cases} p(i, j), p(i, j) \leq 0 \\ \left\lfloor \frac{p(i, j)z_f}{z_0} \right\rfloor, p(i, j) > 0 \end{cases} \quad (129a)$$

Blow Rate 3/4 B code base matrix, suggested base matrix should be added as follows:

Rate 5/6 code:

1 25 55 -1 47 4 -1 91 84 8 86 52 82 33 5 0 36 20 4 77 80 0 -1 -1  
-1 6 -1 36 40 47 12 79 47 -1 41 21 12 71 14 72 0 44 49 0 0 0 0 -1  
51 81 83 4 67 -1 21 -1 31 24 91 61 81 9 86 78 60 88 67 15 -1 -1 0 0  
68 -1 50 15 -1 36 13 10 11 20 53 90 29 92 57 30 84 92 11 66 80 -1 -1 0

In the “8.4.9.2.5.3 Code Rate and Block Size Adjustment”

“Table 333a—LDPC Block Sizes and Code Rates” have some changes as following:

n (bits)	n (bytes)	k (bytes)				Number of subchannels		
		R=1/2	R=2/3	R=3/4	<u>R=5/6</u>	QPSK	16QAM	64QAM
576	72	36	48	54	<u>60</u>	6	3	2
672	84	42	56	63	<u>70</u>	7		
768	96	48	64	72	<u>80</u>	8	4	
864	108	54	72	81	<u>90</u>	9		3
960	120	60	80	90	<u>100</u>	10	5	
1056	132	66	88	99	<u>110</u>	11		
1152	144	72	96	108	<u>120</u>	12	6	4
1248	156	78	104	117	<u>130</u>	13		
1344	168	84	112	126	<u>140</u>	14	7	
1440	180	90	120	135	<u>150</u>	15		5
1536	192	96	128	144	<u>160</u>	16	8	
1632	204	102	136	153	<u>170</u>	17		
1728	216	108	144	162	<u>180</u>	18	9	6
1824	228	114	152	171	<u>190</u>	19		
1920	240	120	160	180	<u>200</u>	20	10	
2016	252	126	168	189	<u>210</u>	21		7
2112	264	132	176	198	<u>220</u>	22	11	
2208	276	138	184	207	<u>230</u>	23		
2304	288	144	192	216	<u>240</u>	24	12	8

In the “11.3.1.1 Uplink burst profile encodings”

<In 11.3.1, p. 514, line 47 add the following text>

11.3.1.1 Uplink burst profile encodings

Insert the following text in the “Value” column of the first row (“FEC code type and modulation type”) of Table 357\_p. 514 of *802.16-REVe/D9*, and change “44..255=Reserved” to “47..255=Reserved”

44 = QPSK (LDPC) 5/6

45 = 16-QAM(LDPC) 5/6

46 = 64-QAM(LDPC) 5/6

In the “11.4.2 Downlink burst profile encodings”

<In 11.4.2, p. 518, line 47 add the following text>

11.4.2 Downlink burst profile encodings

Insert the following text in the “Value” column of the first row (“FEC code type and modulation type”) of Table 361 p. 518 of *802.16-REVe/D9*, and change “44..255=Reserved” to “47..255=Reserved”

44 = QPSK (LDPC) 5/6

45 = 16-QAM(LDPC) 5/6

46 = 64-QAM(LDPC) 5/6