Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	**Changes to OFDM Rates as a Result of Resolution of Comment 263**	
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Re:	Supporting document for Sponsor Ballot Recirculation	
Abstract	Additional changes to the standard are required as a result of the Resolution of Comment 263	
Purpose	The document is intended for consideration within comments resolution process.	
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Changes to OFDM Rates as a Result of Resolution of Comment 263

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7th April 2004

References

1. IEEE, "Draft IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems," IEEE P802.16-REVd/D4-2004.
2. IEEE P802.16 Commentary Database 80216-04/11r5, http://ieee802.org/16/docs/04/80216-04_11r5.zip

Introduction

The resolution of Comment 263 [2] (Bogdan Franovici) was to:

Replace on p. 404, lines 15-20 (on the right) with:
n=1.44/1.25 for channel bandwidths multiple of 1.25 MHz
n=1.72/1.5 for channel bandwidths multiple of 1.5 MHz
n=8/7 for channel bandwidths multiple of 1.75 MHz
n=3.16/2.75 for channel bandwidths multiple of 2.75 MHz
n=8/7 for channel bandwidths not otherwise specified

Precision and Grammar

The first observation is that the fractions should be specified as rational fractions as decimals could be interpreted imprecisely, and the English could be slightly clearer. Updating references to D4 [1] then the comment might read:

Replace on p. 402, lines 13-22 (on the right) with:
n=144/125 for channel bandwidths that are a multiple of 1.25 MHz
n=86/75 for channel bandwidths that are a multiple of 1.5 MHz
n=8/7 for channel bandwidths that are a multiple of 1.75 MHz
n=316/275 for channel bandwidths that are a multiple of 2.75 MHz
n=8/7 for channel bandwidths not otherwise specified.

Missing Families

While it seems unlikely that the standard be widely deployed with all the options available, the current wording allows any bandwidth above 1.25 MHz in 0.25 MHz steps. Therefore there are families of bandwidths not covered by the current wording.
One family of bandwidths that is not included in the above is 2, 4, 8, 16 MHz.
The intention was that within families of bandwidths that were simple powers of 2 of each other, the value of Fs changed by the same power of 2. However, inclusion of the 2 MHz family shows the need for a precedent rule.

Precedence Rule

The third observation is that the precedence of these options is not specified, and as a result there is ambiguity in the standard.

For example, a bandwidth of 7.5 MHz may be selected using either the first or the second of the rules.
A precedence rule is required. It would be straightforward to use the following text, which I propose as the resolution to this issue.

Change 1

Replace on p. 402, lines 13-22 (on the right) with:
For channel bandwidths that are a multiple of 1.25 MHz then n=144/125
else for channel bandwidths that are a multiple of 1.5 MHz then n=86/75
else for channel bandwidths that are a multiple of 1.75 MHz then n=8/7
else for channel bandwidths that are a multiple of 2.0 MHz then n=57/50
else for channel bandwidths that are a multiple of 2.75 MHz then n=316/275
else for channel bandwidths not otherwise specified then n=8/7

I have not included multiples of 2.25, because the 4.5 MHz case would already be trapped by the 1.5 MHz rule and it becomes increasingly complex to arrange all possible bandwidths within the spirit of the change of Comment 263.

Changes to Appendices

As a result of the changes to the sampling rates, the raw bit rates quoted in Table are now incorrect. Indeed there appears to be a couple of errors in that Table irrespective of the changes made by comment 263. The first error is that the fractions quoted are not always correct: this is seen in the red boxes in the "original" version of Table B.28, and the figures for 7MHz in Table B.29 appear to have used 7/6 rather than 8/7 as the value of *n*.
The following change corrects the figures according to the definitions in Draft 4. They also include an additional column for BPSK as added by the resolution of comment #253.

Change 2

Change [1], page 735, lines 1-45 from

Table B.26 - OFDM channelization parameters for licensed bands

Bandwidth (MHz)		OFDM (Nfft = 256)					
		Δf (kHz)	Tb (μs)	G			
				1/32	1/16	1/8	1/4
MMDS (n = 7/6)	1.5	**6 51/61**	146 2/7	4 4/7	9 1/7	18 2/7	36 4/7
	3	13 43/64	73 1/7	2 2/7	4 4/7	9 1/7	18 2/7
	6	27 11/32	36 4/7	1 1/7	2 2/7	4 4/7	9 1/7
	12	54 11/16	18 2/7	4/7	1 1/7	2 2/7	4 4/7
	24	109 3/8	9 1/7	2/7	4/7	1 1/7	2 2/7
ETSI (n = 8/7)	1.75	7 13/16	128	4	8	16	32
	3.5	15 5/8	64	2	4	8	16
	7	31 1/4	32	1	2	4	8
	14	62 1/2	16	1/2	1	2	4
	28	125	8	1/4	1/2	1	2
WCS (n = 7/6)	2.5	**11 35/89**	87 27/35	2 26/35	**5 17/35**	10 34/35	21 33/35
	5	**22 70/89**	43 31/35	1 13/35	2 26/35	**5 17/35**	10 34/35
	10	45 55/96	21 33/35	24/35	1 13/35	2 26/35	**5 17/35**
	15	68 23/64	14 22/35	16/35	32/35	1 29/35	3 23/35

to

Table B.26 - OFDM channelization parameters for licensed bands

Bandwidth (MHz)		OFDM (Nfft = 256)					
		Δf (kHz)	Tb (μs)	G			
				1/32	1/16	1/8	1/4
MMDS (n = 86/75)	1.5	6 23/32	148 36/43	4 28/43	9 13/43	18 26/43	37 9/43
	3	13 7/16	74 18/43	2 14/43	4 28/43	9 13/43	18 26/43
	6	26 7/8	37 9/43	1 7/43	2 14/43	4 28/43	9 13/43
	12	53 3/4	18 26/43	25/43	1 7/43	2 14/43	4 28/43
	24	107 1/2	9 13/43	25/86	25/43	1 7/43	2 14/43
ETSI (n = 8/7)	1.75	7 13/16	128	4	8	16	32
	3.5	15 5/8	64	2	4	8	16
	7	31 1/4	32	1	2	4	8
	14	62 1/2	16	1/2	1	2	4
	28	125	8	1/4	1/2	1	2
WCS (n = 144/125)	2.5	11 1/4	88 8/9	2 7/9	5 5/9	11 1/9	22 2/9
	5	22 1/2	44 4/9	1 7/18	2 7/9	5 5/9	11 1/9
	10	45	22 2/9	25/36	1 7/18	2 7/9	5 5/9
	15	67 1/2	14 22/27	25/54	25/27	1 23/27	3 19/27

Change 3

Change [1], page 737, Lines 1-38 from

Table B.28 - OFDM channelization parameters for license-exempt bands

			OFDM
	n		**8/7**
Bandwidth (MHz)	Nfft		**256**
10	Δf (kHz)		44 9/14
	Tb (μs)		22 2/5
	G	1/32	7/10
		1/16	1 2/5
		1/8	2 4/5
		1/4	5 3/5
20	Δf (kHz)		89 2/7
	Tb (μs)		11 1/5
	G	1/32	
		1/16	7/10
		1/8	1 2/5
		1/4	2 4/5

to

Table B.28 - OFDM channelization parameters for license-exempt bands

			OFDM
	n		**144/125**
Bandwidth (MHz)	Nfft		**256**
10	Δf (kHz)		45
	Tb (μs)		22 2/9
	G	1/32	25/36
		1/16	1 7/18
		1/8	2 7/9
		1/4	5 5/9
20	Δf (kHz)		90
	Tb (μs)		11 1/9
	G	1/32	
		1/16	25/36
		1/8	1 7/18
		1/4	2 7/9

Change 4

Change [1], page 737, Lines 40-62 from

Table B.29 - OFDM raw bitrates (Mbps)

Bandwidth (MHz)	G	QPSK 1/2	QPSK 3/4	16-QAM 1/2	16-QAM 3/4	64-QAM 2/3	64-QAM 3/4
OFDM-256 FFT							
6MHz (MMDS)	1/32	5.09	7.64	10.18	15.27	20.36	22.91
	1/16	4.94	7.41	9.88	14.82	19.76	22.24
	1/8	4.67	7.00	9.33	14.00	18.67	21.00
	1/4	4.20	6.30	8.40	12.60	16.80	18.90
7MHz (ETSI)	1/32	5.94	8.91	11.88	17.82	23.76	26.73
	1/16	5.76	8.65	11.53	17.29	23.06	25.94
	1/8	5.44	8.17	10.89	16.33	21.78	24.50
	1/4	4.90	7.35	9.80	14.70	19.60	22.05
20MHz (U-NII)	1/32						
	1/16	16.13	24.20	32.27	48.40	64.54	72.61
	1/8	15.24	22.86	30.48	45.71	60.95	68.57
	1/4	13.71	20.57	27.43	41.14	54.86	61.71

to

Table B.29 - OFDM raw bitrates (Mbps)

Bandwidth (MHz)	G	BPSK 1/2	QPSK 1/2	QPSK 3/4	16-QAM 1/2	16-QAM 3/4	64-QAM 2/3	64-QAM 3/4
OFDM-256 FFT								
6MHz (MMDS)	1/32	2.50	5.00	7.51	10.01	15.01	20.01	22.52
	1/16	2.43	4.86	7.28	9.71	14.57	19.43	21.85
	1/8	2.29	4.59	6.88	9.17	13.76	18.35	20.64
	1/4	2.06	4.13	6.19	8.26	12.38	16.51	18.58
7MHz (ETSI)	1/32	2.91	5.82	8.73	11.64	17.45	23.27	26.18
	1/16	2.82	5.65	8.47	11.29	16.94	22.59	25.41
	1/8	2.67	5.33	8.00	10.67	16.00	21.33	24.00
	1/4	2.40	4.80	7.20	9.60	14.40	19.20	21.60
20MHz (U-NII)	1/32							
	1/16	8.13	16.26	24.40	32.53	48.79	65.05	73.19
	1/8	7.68	15.36	23.04	30.72	46.08	61.44	69.12
	1/4	6.91	13.82	20.74	27.65	41.47	55.30	62.21