Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Clarification on [4, 8, 16] Midamble Repetition Interval
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Re:	Response to the call for comments IEEE 802.16-2004/Cor1-D2 Corrigendum to IEEE 802.16-2004
Abstract	Midamble repetition intervals [4, 8] are not suitable for a fixed wireless access propagation environment, due to the lack of Doppler induced effects.
Purpose	Change the midamble repetition interval to the previous values [8, 16, 32].
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Clarification on 802.16-2004 OFDM SS Tx Rf and Sampling clock frequency tolerance

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1 Statement of the problem

Midamble repetition interval set of [8, 16, 32] was changed to [4, 8, 16] in Cor1/D1 as a result of the resolution to Comment #139 (Commentary database 80216-04_20r10). The change to the repetition interval was added by the group in its proposed resolution for the following reason:
"In addition, it is recommended to replace the set of midamble spacings of {8,16,32} with {4,8,16}. The value of 32 is not very practical, while the value of 4 may be useful in very high Doppler spread scenarios."

We dispute the assertion that "the value of 32 is not very practical." The use of a midamble may sometimes be necessary in a fixed link, but it would be rare that the channel would be changing quickly enough to require the use of a very small repetition interval. Therefore the interval of 32 would be more useful for fixed links with relatively slowly-varying channels than an interval of 4. Removing the interval of 32 doubles the minimum amount of overhead required should midambles be required or useful.

The repetition interval of 4, with its associated high overhead, would only be used for links in which the SS is highly mobile. Such links are beyond the scope of the 802.16-2004 standard to which this Corrigendum applies as the standard is specifically designed for "Fixed Broadband Wireless Access" (not mobile) links. Further, changing the repetition interval set is to accomodate mobility is beyond the scope of the Corrigendum since it alters decisions made in the creation of the standard rather than implementing a correction. Therefore the set of repetition intervals should remain [8, 16, 32].

2 Justification

We consider a mobile user moving with a given speed (<= 350 km/h) and we try to evaluate the number of OFDM256 symbols per Doppler fade in order to assess the suitable number of midambles for a mobile environment.

Based on [1], the induced fading rates is given by

$$N_R = \sqrt{2\pi} f_m \rho e^{-\rho^2}$$ Equation 2-1

Where:
N_R = the number of fades per second due to the Doppler effect.
ρ = the linear ratio of threshold level to RMS level.
f_m= the maximum Doppler Effect Shift [Hz]

Based on the Equation 2-1, the related Doppler fades per second relative to the mobile user's speed is presented in Appendix 1.

Accordingly, the average number of Doppler induced fades per second for a user moving with 350 km/h (high speed train) is around 2000, which corresponds to an average period of flat fading equating with 0.5 ms.

For a user moving at 110 km/h, the related average number of Doppler induced fades per second is around 620 fades/second with a related average period of flat fading equal to 1.61 ms.
We consider now an OFDM256 signal used in a BW=3.5 MHz.
The related sampling frequency (as stated in [2], section 8.3.2.1 and section 8.3.2.2) , is Fs=4 MHz
The related subcarrier spacing is:

$$\Delta f = \frac{F_s}{N_{FFT}} = \frac{4*10^6}{256} = 15625Hz \qquad \text{Equation 2-2}$$

Based on the Equation 2-2, the related OFDM256 useful symbol time, for BW=3.5 MHz, is:

$$T_b = \frac{1}{\Delta f} = 64\mu s \qquad \text{Equation 2-3}$$

For a conservative case, we consider CP=1/4 (heavy multipath fading content). Accordingly, the OFDM256 symbol time is:

$$T_s = T_b + T_g = 80\mu s \qquad \text{Equation 2-4}$$

A mobile user moving with 350 km/h will experience a fast fading notch at every R_{350} OFDM symbols

$$R_{350} = \frac{0.5*10^{-3}}{80*10^{-6}} = 6.25 \text{ symbols} \qquad \text{Equation 2-5}$$

A mobile user moving with 110 km/h will experience a fast fading notch at every R_{110} OFDM symbols

$$R_{110} = \frac{1.61*10^{-3}}{80*10^{-6}} = 20.1 \text{ symbols} \qquad \text{Equation 2-6}$$

The worst scenario is represented by a user moving at 350 km/h, using a radio communication based on an OFDM256 signal (BW=3.5 MHz), with CP=1/4. Such a user will encounter a high speed Doppler induced fade at every 6.3 OFDM symbols.

Even a regular mobile user not using a high-speed train would not require a midamble repetition rate of 4.

3 Proposed solution

A fixed wireless access user will not be subject to any Doppler induced fading. Therefore midambles repetition rates of 4 or 8 are not required for this kind of propagation environment.

Therefore we propose to revert back to the previous midamble repetition rate structure of [8, 16, 32].

4 Specific text changes.

Undo all changes altering the set of repetition intervals. Specifically:

Page 65, line 40:
Change the 'Midamble Repetition Interval' field in Table 228 as indicated:
0b00: Preamble only
0b01: Interval 9: Midamble after every 848 data symbols
0b10: Interval 17: Midamble after every 16816 data symbols
0b11: Interval 33: Midamble after every 321632 data symbols

Page 66, line 50:
Change the 'Midamble Repetition Interval' field in Table 245 as indicated:
0b00: Preamble only
0b01: Interval 9: Midamble after every 848 data symbols
0b10: Interval 17: Midamble after every 16816 data symbols
0b11: Interval 33: Midamble after every 321632 data symbols

5 Reference.

[1] T.S. Rappaport: “Wireless Communications: Principles and Practice (2nd Edition)”, Prentice Hall, 2001
[2] working document IEEE 802.16-2004/Cor1-D2, 2005-04-04.
[3] IEEE P802.16-REVd/D5-2005, May 2004

6 Appendix 1

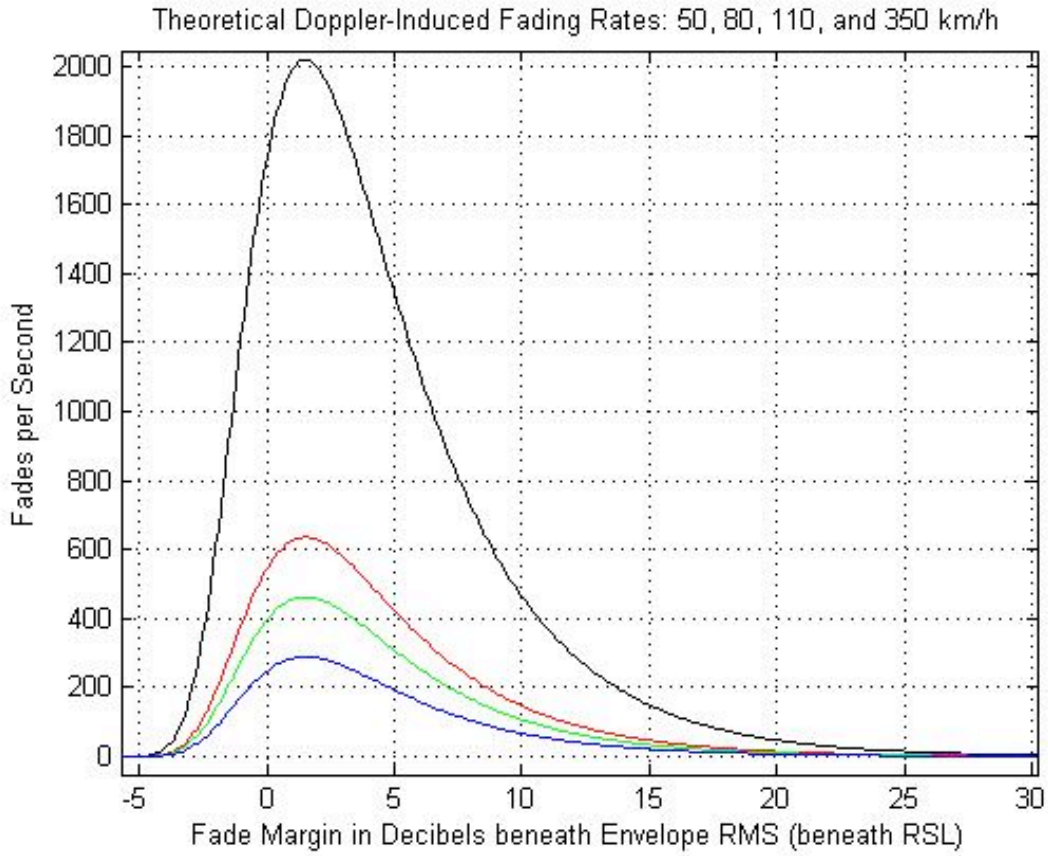

Figure 6-1. Number of Doppler induced fades per second for different speed rates.