Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	**C80216maint-05_106.doc**	
Date Submitted	**2005-04-28**	
Source(s)	[Darcy Poulin [SiGe Semiconductor] [Paul Piggin] [Cygnus Multimedia Communications]	Voice: [613-820-9244 x274] Fax: [Fax Number] [dp@sige.com ppiggin@cygnuscom.com]
Re:	IEEE P80216_Cor1_D2	
Abstract	Correction to make EVM and Receiver SNR consistent	
Purpose	EVM and Rx SNR are inconsistent with one another. In addition, there are many inconsistencies throughout section 8.3, 8.4, and 12.4 specifying EVM and Rx SNR. This submission attempts to resolve these inconsistencies.	
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.	
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.	
Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.	

Introduction

There are a number of inconsistencies in the 802.16-2004 standard in specifying Tx EVM requirements. For example, table 264 (OFDM-PHY) specifies that the Tx EVM for 64-QAM-3/4 must be -31 dB. Table 336 (OFDMA-PHY) specifies that the EVM must be -31.4. Table 413 (minimum performance requirement for OFDMA in the Systems Profiles chapter) calls for a minimum EVM of -34.4 dB.

Most of these discrepancies were the result of an initial (incorrect) assumption on Rx SNR requirements. Tx EVM was initially specified so that the Tx SNR would cause less than 0.5 dB reduction in overall Rx SNR. However, the original Rx SNR on which this was based was too high. This error was corrected, but many instances of Tx EVM were not corrected, leading to the inconsistencies noted above.

We believe that the required Rx SNR has been properly captured by Tal Kaitz and Naftali Chayat in C80216d-03_44. These changes were only partly propagated through in to the 802.16-2004 standard.

This document attempts to identify and correct all of the inconsistencies in Tx EVM in the 802.16-2004 document, and to correct any remaining Rx SNR errors that were not implemented after the Kaitz and Chayat document.

Discussion

As it currently stands, the EVM (in table 264) and Rx SNR (in table 266) are inconsistent with one another.

Section 8.3.10.1.2 states that the receiver SNR can not degrade by more than 0.5 dB due to the transmitter's SNR. Table 264 states that (for example) 64-QAM-3/4 requires a relative constellation error of -31 dB. Table 266 states that the receiver SNR requirements for 64-QAM-3/4 is 24.4 dB.

These values are mutually inconsistent. If the Rx SNR is 24.4 dB, adding in a -31 dB Tx impairment results in a net SNR of 23.5 dB. This is a 0.9 dB reduction in Rx SNR, significantly worse than the 0.5 dB requirement. In order to have the transmitter impact a 24.4dB Rx SNR by only 0.5 dB, the required transmit EVM would be -33.9 dB.

We believe that the error is in table 266. The document C80216d-03_44, submitted by Tal Kaitz and Naftali Chayat of Alvarion in 2003, shows that the receiver SNR should be as shown below:

Modulation	Coding rate	Required SNR for BER=1e-6 [dB]
QPSK	½	6
QPSK	¾	8.5
QAM16	½	11.5
QAM16	¾	15
QAM64	2/3	18.5
QAM64	¾	21

With these numbers for required receiver SNR, then a -31 dB EVM on the transmitter gives a 0.4 dB reduction in overall SNR.

Suggested Corrections to 802.16-2004:

8.3.10.1.2
New text becomes "To ensure that the receiver SNR does not degrade by more than **0.4 dB** due to the transmitter SNR, the relative constellation RMS error, averaged over subcarriers, OFDM frames, and packets, shall not exceed a burst profile dependent value according to table 264."

Table 264 remains unchanged.

8.3.11.1
Table 266 should be:

Modulation	Coding rate	Required SNR for BER=1e-6 [dB]
QPSK	½	6
QPSK	¾	8.5

QAM16	½	11.5
QAM16	¾	15
QAM64	2/3	18.5
QAM64	¾	21

8.4.12.3:
Change the paragraph to read: "To ensure that the receiver SNR does not degrade by more than **0.4 dB** due to the transmitter SNR, the relative constellation RMS error, averaged over subcarriers, OFDMA frames, and packets, shall not exceed a burst profile dependent value according to table 336."

Table 336 should be identical to table 264 (EVM values are -13, -16, -18.5, -21.5, -25, -28.5, and -31 dB—all values in table 336 are 0.4 dB worse than these values).

8.4.13.1:
Section 8.4.13.1 must be made to look the same as section 8.3.11.1. Remove all references to Eb/N0 (see document C80216d-03_44 for justification) in table 338, and change Table 338 so that the receiver SNR is 6, 8.5, 11.5, 15, 18.5, and 21. This will make the Receiver SNR requirements in table 338 identical to those in table 266 of 8.3.11.1.

12.4.3.1.5
In table 413, Tx relative constellation errors should be -16, -18.5, -21.5, -25, -28.5, and -31 dB (not -19.4, -21.2, -26.4, -28.2, -32.7, -34.4).

12.4.3.2
In table 414, requirements of Tx relative constellation error are listed. These requirements are covered in table 413, and should be removed in table 414. Note that none of the other profiles includes EVM, so removing the EVM requirement here makes the table consistent with all other profiles.