Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Changes to constellation errors
Date Submitted	**2003-07-03**
Source(s)	Tal Kaitz Naftali Chayat 21, HaBarzel Street Tel Aviv, Israel	Voice: +972 54 22 56 48 Fax: +972 3 6456273 mailto: tal.kaitz@alvarion.com
Re:	IEEE 802.16d Sponsor Ballot
Abstract	
Purpose	
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

0

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>.

Constellation Errors and Receiver SNR

Tal Kaitz, Naftali Chayat

Alvarion

Introduction

The required constellation errors for the OFDM PHY (section 8.4.9.1.2 table 116bi) are too high. For instance, the required constellation error for QAM64 rate ¾ is 34.4dB. This may be beyond the capabilities of some low cost radio chip sets.

  These values are derived tables by adding 10dB to the receiver SNR values (8.4.10.1 table 116bk). The problem is that the required SNR values are also too high. This may be OK for receiver sensitivity (i.e. maintain some implementation margin) but we should not derive the transmitter requirements from these relaxed values, or we may over specify the transmitter.
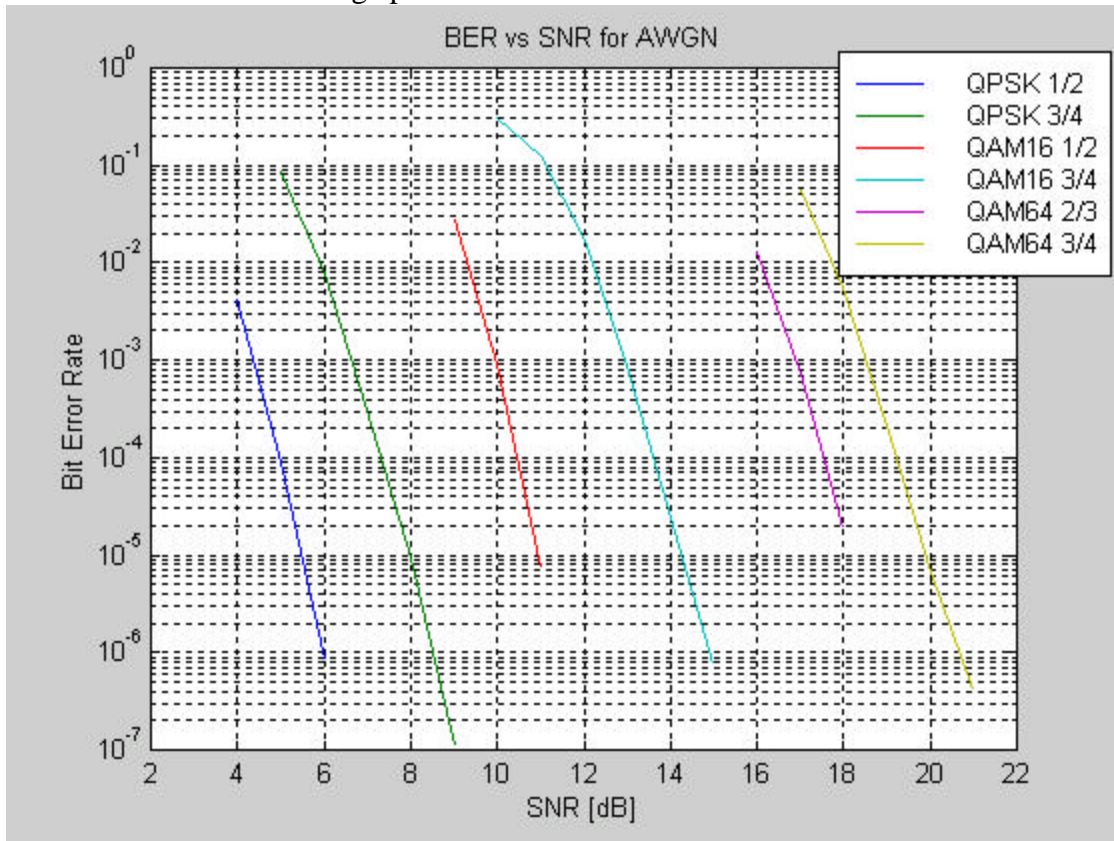
  We agree with the concept of requiring constellation errors to be 10dB above receiver SNR. This results in a degradation of 0.4dB for the AWGN and more in the case of multipath. We should, however, use realistic SNR values.

Realistic SNR values

To determine the realistic SNR values the result of simulations are shown. The simulation conditions are:
1. Mandatory CC+RS coding.
2. Full BW
3. 400 bytes packets. 20K packets were simulated. (64Mbits)
4. Channel estimation from preamble.
5. No frequency offsets, quantization effects phase noise etc. (These are considered part of implementation loss).

2

The results are shown in the graph and table below[1].

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

---

[1] Note: Sometimes the curves stops at 10^{-5}. This is because simulation steps were 1dB and the RS+CC error curves decay rapidly.

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

Table 1Required SNR values

Recommended transmitter constellation error

The new constellation error based on table 1 is given below

Modulation	Coding rate	Required constellation error. [dB]
QPSK	½	-16
QPSK	¾	-18.5
QAM16	½	-21.5
QAM16	¾	-25
QAM64	2/3	-28.5
QAM64	¾	-31

Receiver SNR

It is recommended to drop the Eb/No column from table 116bk. Because:
   a. Eb/No does not belong here.
   b. No information is given how Eb/No is converted to SNR.
   c. Strangely enough , Eb/No does not depend on the coding rate.

The SNR values should be updated based on table 1 above.

4