Project	**IEEE 802.20 Working Group on Mobile Broadband Wireless Access** <http://ieee802.org/20/>
Title	**Updated Proposed Resolution to 802.20 Ballot Comment on Minimum Performance Parameters**
Date Submitted	**2007-09-11**
Source(s)	Jim Tomcik Qualcomm Incorporated 5775 Morehouse Drive San Diego, CA, 92121 Voice: 858-658-3231 Fax: 858-658-2113 Email: jtomcik@qualcomm.com
Re:	Ballot Comment Resolution for 802.20
Abstract	This contribution proposes a resolution to ballot comment 36 (submitted by Victor Hou) on the current 802.20 draft calling for specification of RF parameters. RF parameters that may affect the interoperability aspects of the technology are specified here. Other parameters not related to interoperability aspects will be covered in a proposed new project, an 802.20 Minimum Performance specification.
Purpose	For consideration of 802.20 in its efforts to adopt resolutions for outstanding comments from LB1, and LB2.
Notice	
Release	
Patent Policy	

Introduction

During the course of developing the 802.20 draft, ballot comment 36 calling for the addition of minimum performance sections for the AN and AT was raised in reference to the 802.20 FDD and Wideband TDD technologies balloted in LB1 and LB2. Although there is a tradition in the mobile wireless industry that minimum performance is best addressed in a document (or documents) separate from the air interface specification, this 802.20 member would like to see a minimal set of requirements in the air interface specification itself.

Including a full treatment of minimum performance within the 802.20 specification is problematic for several reasons. First, since the technology is still being developed, the air interface waveform is not totally stable, although the numbers of comments related to the core technology have been decreasing. A full treatment of minimum performance and the analysis required relies on having a stabilized air interface waveform so that implementers can begin their work to create systems and devices compliant with the technology. Second, minimum performance is tightly tied to the regulatory environment within which equipment using the technology is deployed. Different environments and the constraints imposed by regulators significantly affect the performance obtainable from a wireless technology. To specify parameters dictated by regulatory regimes in the baseline air interface would unduly limit the technology applicability. Finally, minimum performance requirements are usually determined by developers, as they produce equipment. It is early in the life of the 802.20 technology for this to happen, once again because the air interface is in development.

Despite these difficult issues, this contribution proposes a compromise approach, identifying parameters and requirements that could be specified independent of regulatory environment, and contributing significantly to improved interoperability, and performance of the technology in a manner consistent with the 802.20 evaluations contributed in the technology selection phase of the project.

RF Requirements in 802.16 and 802.16e

Referring to the 802.16 OFDMA PHY and the 802.16e amendments text as a starting point for what to specify here is reasonable since 802.20 targets licensed use cases with an OFDMA technology as well. Table 1 illustrates the transmitter and receiver performance requirements from the 802.16 OFDMA PHY and 802.16e, and references the applicable sections from approved versions of these documents.

Table 1 further illustrates the nature of each requirement section, and attempts to classify the requirements as (1) Regulatory, (2) Equipment Performance, and (3) Interoperability affecting requirements. As shown in the table, the requirements in the 802.16 documents contain a mixture of regulatory, interoperability, and equipment performance requirements. Although equipment performance and regulatory guidelines are “nice to have” quantities, these vary depending on the application for the technology, and are not strictly necessary from an interoperability perspective.

One item in the table, "MS Autonomous Neighbor Cell Scanning" included in the 802.16 documents, is marked as not applicable to 802.20 Wideband TDD and FDD modes because other cell scanning and "tune away" is handled differently, under control of the AN.

Table 1. IEEE 802.16 RF Requirements and Classifications

Quantity	802.16 OFDMA	802.16e Section	Classification
Transmitter Spectral Flatness	8.4.12.2	8.4.12.2	Regulatory
Transmitter Reference Timing Accuracy	8.4.12.3 (New Sec)		Interoperability
Transmit Power Level Control		8.4.12.1	Interoperability
Transmitter Constellation Error		8.4.12.3 (renumbered to 8.4.12.4)	Equipment Performance
Receiver Sensitivity	8.4.13.1.1	8.4.13.1	Interoperability
MS Uplink Transmit Time Tracking Accuracy	8.4.13.1.2		Interoperability
MS Autonomous Neighbor Cell Scanning	8.4.13.1.3		Not applicable to 802.20.
Receiver Adjacent channel and Alternate Channel Rejection		8.4.13.1	Equipment Performance
Receiver Maximum Input Signal		8.4.13.3	Equipment Performance
Receiver Maximum Tolerable Signal		8.4.13.4	Equipment Performance
Center Frequency and Symbol Clock Tolerance		8.4.14.1	Interoperability

Approach

The two sections proposed here to resolve the 802.20 ballot comment are included specifically to address interoperability concerns, and leave regulatory and equipment performance concerns to be addressed in a proposed new project in 802.20, as discussed at the 2007-01 London Interim meeting of 802.20.

Proposed changes:

Before page 635, line 31. Replace the section with the following text (section title is slightly modified and a reference added):

5.3.1.4.1 Transmit Burst Timing Synchronization Requirements

At the AT, in Wideband TDD mode, no burst timing requirement is necessary because the AT is synchronized with the AN (see x.x.x – Frequency Control Requirements). To prevent accumulation of long term errors, the AT should adaptively correct its timing based on the observed AN waveform.

Burst timing synchronization does not apply to FDD mode.

*Page 636, line 2. Change the section title to "**Frequency Control Requirements**" to emphasize this is a requirement section.*

Page 636, line 5. Add the following section:

5.3.1.5.2 AT Transmit Waveform Quality

The goal is to make sure that the receiver at AN does not degrade by more than 0.5dB in performance due to transmitter imperfections. The metric used is denoted by mean square constellation error (MSCE) which is basically the mean square error between the ideal constellation point and the actual one to be received after considering transmit imperfections

5.3.1.5.2.1 Procedure for AT MSCE Measurement

The following procedure shall be followed:

1. The AT is assigned all tiles for data except for those designated for guard band
2. The DC tone shall not be populated
3. The transmitted signal is cable-connected to the receiver with two receive antennas. Denote the received samples on antennas 1 and 2 by y1 and y2 respectively
4. After down conversion, the receiver performs time and frequency offsets calculation
5. Time and frequency correction shall be applied to the received signal yielding to samples z1 and z2 from antenna 1 and antenna 2 respectively
6. Using pilots, for each data tone, estimate the average channel per Rx antenna, denote the estimates by h1 and h2 for antenna 1 and antenna 2 respectively
7. The actual received constellation point on that tone is given by $\hat{x} = \frac{\left(h_1^* z_1 + h_2^* z_2\right)}{\left(\left|h_1\right|^2 + \left|h_2\right|^2\right)}$,

   where $a*$ is the complex conjugate of a and $|a|$ is the absolute value of a

8. Find the closest constellation point to $\hat{x}$ in Euclidean distance and denote that point by x
9. Find the MSCE metric given by

$$\varepsilon = \frac{\sum_{j=1}^{N_f}\sum_{k=1}^{N_p}\left(x_I(j,k)-\hat{x}_I(j,k)\right)^2+\left(x_Q(j,k)-\hat{x}_Q(j,k)\right)^2}{\sum_{j=1}^{N_f}\sum_{k=1}^{N_p}\left(x_I(j,k)\right)^2+\left(x_Q(j,k)\right)^2}$$ where

a_I, a_Q are the real and imaginary parts of a, N_p is the number of modulation symbols in the packet and N_f is the number of frames used for averaging MSCE

The MSCE shall not exceed the values in Table 2

Table 2: MSCE values as a function of packet format

Packet Format	Modulation	Spectral efficiency	MSCE (dB)
2 – 1st transmission	QPSK	0.94	-15
4– 1st transmission	16QAM	2.0	-21
6– 1st transmission	64QAM	3.0	-26

Page 636, line 19. Replace the section by the following:

5.3.2.4.1 Receiver Sensitivity Requirements

The low sensitivity level is defined for PF 2 first transmission (which corresponds to a spectral efficiency of 0.94 and QPSK modulation), a PER of 1%, pilot format 1, and utilizing all tones except for those designated for guard band. The low sensitivity level shall not exceed the values defined in Table 3.

Table 3: Low Sensitivity Level

Bandwidth (MHz)	Sensitivity (dBm)
5	-94
10	-91
20	-88

The high sensitivity level is defined for PF 6 first transmission (which corresponds to a spectral efficiency of 3.0 and 64QAM modulation), a PER of 1%, pilot format 1, and utilizing all tones except for those designated for guard band. The high sensitivity level shall not exceed the values defined in Table 4

Table 4:High Sensitivity Level

Bandwidth (MHz)	Sensitivity (dBm)
5	-83
10	-80
20	-77

The received power level is averaged over data frames only and hence the above definition works for FDD and TDD.

<u>Page 696, line 22. Replace the section by the following (Also include the receive center frequency):</u>

5.4.1.6.1 Frequency Control Requirements

At the Access Node, the transmitted center frequency, receive center frequency, and the symbol clock frequency should be derived from the system time (see 1.4.14). At the AN, the reference frequency accuracy shall be better than +/- 1% of the subcarrier spacing.

<u>Page 696, line 30. Insert a section as following:</u>

5.4.1.8 AN Transmit Waveform Quality

The goal is to make sure that the receiver at AT does not degrade by more than 0.5dB in performance due to transmitter imperfections.

5.4.1.8.1 Procedure for AN MSCE Measurement

The following procedure shall be followed:

1. The AN is assigned all tiles for data except for those designated for guard band
2. The DC tone shall not be populated
3. The signal is transmitted from the first effective antenna and is cable-connected to the receiver with two receive antennas. Denote the received samples on antennas 1 and 2 by y1 and y2 respectively
4. After down conversion, the receiver performs time and frequency offsets calculation
5. Time and frequency correction shall be applied to the received signal yielding to samples z1 and z2 from antenna 1 and antenna 2 respectively
6. Using pilots, for each data tone, estimate the average channel per Rx antenna, denote the estimates by h1 and h2 for antenna 1 and antenna 2 respectively
7. The actual received constellation point on that tone is given by $\hat{x} = \frac{\left(h_1^* z_1 + h_2^* z_2\right)}{\left(|h_1|^2 + |h_2|^2\right)}$,
8. Find the closest constellation point to $\hat{x}$ in Euclidean distance and denote that point by x
9. Find the MSCE metric given by

$$\varepsilon = \frac{\sum_{j=1}^{N_f}\sum_{k=1}^{N_p}\left(x_I(j,k)-\hat{x}_I(j,k)\right)^2+\left(x_Q(j,k)-\hat{x}_Q(j,k)\right)^2}{\sum_{j=1}^{N_f}\sum_{k=1}^{N_p}\left(x_I(j,k)\right)^2+\left(x_Q(j,k)\right)^2}$$ where

a_I, a_Q are the real and imaginary parts of a, N_p is the number of modulation symbols in the packet and N_f is the number of frames used for averaging MSCE

The MSCE shall not exceed the values in Table 2

Page 698, line 28. Replace till page 699, line 5 by the following (The sensitivity is defined in the AT section. The frequency control is merged into transmitter part).:

5.4.2.4.1 Receiver Sensitivity Requirements

The AN receiver sensitivity is as defined in the AT section. The low and the high sensitivity levels shall not exceed the values in Table 3 and Table 4 respectively.