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Re:	IEEE P802.16-2004/ Cor1-D3
Abstract	Corrections for EVM definitions in OFDMA PHY
Purpose	Adopt changes
Notice	
Release	
Patent Policy and Procedures	

Corrections for EVM definitions in OFDMA PHY

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1. Motivation

RMS constellation error definition seems to be borrowed from OFDM and not relevant for OFDMA this contribution proposes corrections for the definition.

2. Details

- In the error measurement procedure, the compensation for the impairment has following problem.
  - It seems that the procedure tries to compensate the phase noise and channel estimation error separately.
  - However, the procedure leads to compensate the phase impairment two times.
  - Further, the phase noise term that can be estimated is only the common phase noise term and the common phase noise term can be estimated during the channel estimation.
- In the current procedure, DL/UL shall follow the same error measurement procedure.
  - In OFDMA mode, it is reasonable for SS to send part of the used subcarriers of its subchannelization and power limit.
  - So it is better to define separate procedure.
- There is no definition/limitations on errors (spurious emissions) on unmodulated subcarriers in the UL. These errors are inherent in any IFFT based transmitter and will degrade performance of other subscribers that transmit in parallel, therefore they should be bounded.

3. Changes summary

[add section 8.4.12.3 to the document]

[Note: the following text includes editing instructions to modify 8.4.12.3 in 802.16-2004 which are to be included in 802.16Cor1/D4]

8.4.12.3 Transmitter constellation error and test method

[Replace the text starting at p.626 from "The sampled signal…" with the following text below]

8.4.12.3.1 RMS constellation error measurement for BS (downlink):

The test may be performed in any permutation zone like PUSC. ~~The FCH configuration (used PUSC groups) shall be determined according to the desired BS configuration.~~ The sampled signal shall be processed in a manner similar to an actual receiver, according to the following steps:

a) The BS under test shall transmit all subchannels defined in the symbol structure (see 8.4.6).
b) Locate the Preamble.
c) Perform timing and frequency estimation.
d) Compensate the timing offset as estimated.
e) The received signal shall be de-rotated according to estimated frequency offset.
f) The complex channel response coefficients shall be estimated for each of the subcarriers.
g) Divide each subcarrier value ~~with~~ by ~~a~~ the complex estimated channel response coefficient.
h) For each data-carrying subcarrier, find the closest constellation point and compute the Euclidean distance from it.
i) Compute the RMS average of all errors in a packet. It is given by equation 149 ~~:~~

8.4.12.3.2 RMS constellation error measurement for SS

The sampled signal shall be processed in a manner similar to an actual receiver, according to the following steps:

a) The SS under test shall transmit on part of the UL subchannels. Recommended value is 1/4 of the UL subchannels.
b) The tester will locate a complete UL subframe.
c) Perform timing and frequency estimation.
d) Compensate the timing offset as estimated.
e) The received signal shall be de-rotated according to estimated frequency offset.
f) ~~Estimate the averaged timing and frequency offset.~~
g) ~~The packet shall be de-rotated according to estimated timing and frequency offset.~~
h) Estimate the average channel according to the pilots.
i) Divide each subcarrier value with a complex estimated channel response coefficient.
j) For each data-carrying subcarrier, find the closest constellation point and compute the Euclidean distance from it.
k) Compute the RMS average of all errors in a packet. It is given by equation (149).
l) Normal RMS constellation error measurement shall be performed in scenarios where the number of modulated subcarriers is constant across symbols.
m) In case the number of subcarriers varies between symbols, it is recommended to measure RMS constellation error separately for symbols with different power levels.

8.4.12.3.3 calculation of RMS constellation error

$$Error_{RMS}^2 = \frac{1}{N_f}\sum_{i=1}^{N_f}\frac{\sum_{j=1}^{L_p}\sum_{k\in S}\left(\left|I(i,j,k)-I_0(i,j,k)\right|^2+\left|Q(i,j,k)-Q_0(i,j,k)\right|^2\right)}{\sum_{j=1}^{L_p}\sum_{k\in S}\left(I_0(i,j,k)^2+Q_0(i,j,k)^2\right)} \quad (149)$$

Where:

L_P is the length of the packet;

N_f is the number of frames for the measurement;

($I_0(i,j,k)$, $Q_0(i,j,k)$) denotes the ideal symbol point of the *I* th frame, *j* th OFDMA symbol of the frame, *k* th subcarrier of the OFDMA symbol in the complex plane;

($I(i,j,k)$, $Q(i,j,k)$) denotes the observed point of the *i*-th frame, *j*-th OFDMA symbol of the frame,

k-th subcarrier, of the OFDMA symbol in the complex plane;

S is the group of the modulated data subcarriers where the measurement is performed.

8.4.12.3.4 Unmodulated subcarrier errors for SS

Unmodulated subcarrier errors is a measure of the amount of noise emitted by the SS on the unmodulated subcarriers (within the used subcarriers range). The measure is relative to the power emitted by the SS on the modulated subcarriers.

a) The SS under test shall transmit on part of the UL subchannels. ~~Recommended value is 1/4 of the UL subchannels.~~
b) The tester will locate a complete UL subframe.
c) Perform timing and frequency estimation.
d) Compensate the timing offset as estimated.
e) The received signal shall be de-rotated according to estimated frequency offset.~~Estimate the averaged timing and frequency offset.~~
f) ~~The packet shall be de-rotated according to estimated timing and frequency offset.~~
g) The unmodulated subcarrier errors (relative to the transmitted power) shall be measured according to equation (149a)
h) The value of the unmodulated subcarrier error shall not exceed the maximum values defined in Table 336 (Allowed relative constellation error versus data rate).

$$Error_{RMS}^2 = \frac{1}{N_f}\sum_{i=1}^{N_f}\frac{\sum_{j=1}^{L_p}\sum_{k\in S_u}\left(I(i,j,k)^2+Q(i,j,k)^2\right)}{\sum_{j=1}^{L_p}\sum_{k\in S}\left(I_0(i,j,k)^2+Q_0(i,j,k)^2\right)} \quad (149a)$$

Where:

L_P is the length of the packet;

N_f is the number of frames for the measurement;

($I(i,j,k)$, $Q(i,j,k)$) denotes the observed point of the *i*-th frame, *j*-th OFDMA symbol of the frame,

k-th subcarrier, of the OFDMA symbol in the complex plane, before equalization (i.e. after step (~~d~~e)).

S is the group of the modulated data subcarriers where the measurement is performed.

Su is the group of the un-modulated data subcarriers. It includes all subcarriers in the range 0 .. Nused-1, except the DC subcarrier and the modulated subcarriers (in S).