Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Correction to CINR and REP-REQ/RSP
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Re:	Call for comments, 802.16maint task group
Abstract	The mechanisms that are currently defined, i.e. CINR measurements, CQICH and REP-REQ/RSP, do not provide sufficient support to enable decent link adaptation for various deployment scenarios such as frequency reuse of 1 or 3. No mechanism provides the BS with any knowledge on the frequency selectivity of the channel and the noise. Define specifically CINR measurement methods. REP-REQ/RSP is augmented with Time and Frequency Selectivity Characterization
Purpose	Correct CINR and REP-REQ/RSP
Notice	
Release	
Patent Policy and Procedures	

Support for link adaptation

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1 Problem statement

The mechanisms that are currently defined, i.e. CINR measurements, CQICH and REP-REQ/RSP, do not provide sufficient support to enable decent link adaptation for various deployment scenarios such as frequency reuse of 1 or 3. No mechanism provides the BS with any knowledge on the frequency selectivity of the channel and the noise (especially prominent with partially loaded cells and with multipath). Without a proper metric to reflect the channel realization, the base station is unable to provide accurate link adaptation which results in larger fade margins and reduction in system capacity.

In this contribution we propose to enhance the current mechanisms to provide the needed support to implement efficient link adaptation.

Issues with CINR reports:

- The text describing the CINR measurement does not provide any guidance for the measurement procedure. Different SSs may use a totally different set of assumptions, all unknown to the BS, for CINR measurements. Therefore, a minimal set of measurement options should be defined.
- CINR measurements can be conveyed via CQICH and REP-REQ/RSP. The two mechanisms should be kept distinct and the purpose of each one better enforced.

Issues with REP-REQ reports:

- There is no mechanism for REP-REQ/RSP to provide any information about the frequency selectivity or time selectivity of the channel. This information is critical (in addition to CINR), for supporting proper link adaptation algorithms at the BS. Therefore, additional message types should be added to provide the BS with sufficient information to properly schedule channel quality feedback rates (e.g., periodicity of CQICH) and perform link adaptation.

The following is an outline of the proposed changes:

1. Define specifically CINR measurement methods.
2. REP-REQ/RSP is augmented with Time and Frequency Selectivity Characterization.

2 Detailed Text Changes

[Change section 6.3.17.4 into 6.4.18]
[Change first sentence]
This subclause describes the operation scenarios and requirement of CQICH~~, which is designed for H-ARQ enabled MS~~.

[Add the following text in 6.3.18 CQICH Operations]

CINR to be reported via CQICH shall be measured according to the measurement method specified by the DCD message.

[Change the first sentence of 8.4.11.3]

When CINR measurements are mandated by the BS, an SS shall obtain CINR measurement (implementation-specific) according to the measurement method specified by the DCD message.

[Add the following text at the end of section 8.4.113]

[Note: the correct table number should replace XXX]

8.4.11.4 Frequency Selectivity Characterization

In order to characterize the relationship between channel frequency selectivity and link performance in a compact form, the parameters of an effective CINR versus weighting parameter *ß* curve can be sent from the SS to the BS. The EESM method for computing effective CINR provides the BS with a tool to better estimate the optimal MCS and/or boosting level for the SS by accounting for the frequency selectivity of the signal.

When requested by the BS, the SS shall compute a quadratic approximation of an effective CINR (dB) vs. $ß_{dB}$=10log(*ß*) curve. The quadratic approximation is represented as:

$$EESM_{dB}(ß_{dB}) = a + b\, ß_{dB} + c\, ß_{dB}^{2}$$

Where *a*, *b* and *c* are the Y-intercept, linear, and quadratic parameters, respectively, that are to be estimated by the SS. The quadratic approximation is derived by performing a curve fit to an experimentally derived EESM effective CINR versus *ß* curve. The experimental curve is obtained from:

$$EESM(\{g_1',\ldots,g_N'\}, b) = -b \cdot \ln\left(\frac{1}{N}\sum_{i=1}^{N}\exp\left(-\frac{g_i'}{b}\right)\right)$$

where:

$$g_i' = \frac{10 g_i}{\bar{g}} \text{ with } \bar{g} = \frac{1}{N}\sum_{j=1}^{N} g_j$$

$\{g_1,\ldots,g_N\}$ are a set of per-subcarrier CINR values (in linear scale) corresponding to the subcarriers used for CINR measurement. The CINR values shall not include the effects of data boosting.

b is the parameter in linear scale that is swept over to generate the experimental curve

Note that the scaled versions of the per-subcarrier CINRs (g_i') are used when calculating the curve parameters in order to limit the dynamic range needed to represent the parameters *a*, *b* and *c*. The curve parameters *a*, *b* and *c*, shall be calculated based on a curve fitting over the range of $-5 \le b_{dB} < 20$. The curve parameters and the CINR, $\bar{g}$, shall be sent to the BS when requested in a REP_REQ message or, if the curve parameters have changed significantly (e.g., due to a drastic change in the channel power delay profile), in an unsolicited fashion.

The per-subcarrier CINR values used for the experimental curve shall be measured on the preamble or on pilots / data of the first PUSC zone as instructed by the DCD message.

8.4.11.5 Time Selectivity Characterization

In order to provide the BS with an indication of how long a reported CINR value from an SS remains valid, the BS may request a time selectivity estimate using a REP-REQ message. When requested, the SS shall respond with an estimate of the time, in units of frames, that any individual CINR measurement (without averaging) is expected to remain valid.

In addition, the BS may request that an SS provide estimated samples from a CINR cumulative distribution function (CDF). The BS will specify the number of CINR measurements used by the SS to determine the estimated CDF samples. The number of CINR measurements is specified in the units of frames, with one CINR measurement per frame. An estimated CDF point is determined by the SS as follows: If the BS requests an X% CDF point, denoted as CINR_X%, then the SS shall determine CINR_X% as the value for which X% of the measured CINR values are less than or equal to CINR_X%. The CINR values used to estimate the CDF points shall be measured on the preamble or on pilots / data of the first PUSC zone as instructed by the DCD message.

The SS may also send time selectivity characterization reports to the BS using REP-RSP in an unsolicited fashion.

[Add the following text at the end of section 11.4.2]
[Note: the correct table number should replace XXX]
[Note: the correct type number should replace XX]

11.4.3 DCD CINR measurement method

Table XXX – DCD CINR measurement method

Name	Type	Length	Value
Preferred CINR measurement method	XX	1	Bit0: measurement location for CQICH ('0' for preamble, '1' for first PUSC zone) Bit1: measurement type for CQICH ('0' to include only occupied subcarriers, '1' to include all subcarriers). Bit2: measurement location for REP-REQ/RSP ('0' for preamble, '1' for first PUSC zone) Bit3: measurement type for REP-REQ/RSP ('0' to include only occupied subcarriers, '1' to include all subcarriers). Bit4-7: *Reserved*

Description of Preferred CINR measurement method

Measurement location: If measurement signal is '0', CQI shall report instantaneous CINR estimated on the preamble, after compensating for preamble power boosting. If measurement signal is '1', CQI shall report instantaneous CINR estimated from pilots and/or data (excluding FCH subchannels) in the first two OFDMA symbols in the first PUSC zone.

Measurement type: If measurement type is '0', CINR shall be solely estimated on subcarriers that the serving BS is trans mitting on within the measurement location. If measurement type is '1', CINR shall be estimated for frequency reuse 1, which takes interference into account from both the occupied and unused subcarriers within the measurement location (excluding DC and gua rd subcarriers).

[Add the following new section 11.8.3.7.X]

11.8.3.7.X Support for CINR Measurement methods

These fields indicate the support of optional CINR measurement methods by a WirelessMAN-OFDMA PHY SS. These fields are not used for other PHY specifications.

The first bit indicates the capability to perform CINR measurement from the preamble.
The second bit indicates the capability to perform CINR measurement from the first PUSC zone as specified in 11.4.3.
The third bit indicates the capability to perform CINR measurement from the preamble using all subcarriers as specified in 11.4.3.
The second bit indicates the capability to perform CINR measurement from the first PUSC zone using all subcarriers as specified in 11.4.3.

Type	Length	Value	Scope
XXX	1	Bit #0: CINR measurement from the preamble Bit #1: CINR measurement fom first PUSC zone Bit #2: all-subcarriers CINR measurement for preamble Bit #3: all-subcarriers CINR measurement for first PUSC zone Bit #4~7: *Reserved*; shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

[Add the following new section 11.8.3.7.X]

11.8.3.7.X Support for Optional Frequency Selectivity and Time Selectivity Characterization Measurements

These fields indicate the support of optional frequency and time selectivity measurements by a WirelessMAN-OFDMA PHY SS. These fields are not used for other PHY specifications.

The first bit indicates the capability to perform EESM effective CINR versus β curve parameter reporting. A value of 0 indicates not supported, and a value of 1 indicates supported.

The second bit indicates the capability to perform CINR time validity reporting. A value of 0 indicates not supported, and a value of 1 indicates supported.

The third bit indicates the capability to perform CINR CDF sample reporting. A value of 0 indicates not supported, and a value of 1 indicates supported.

Type	Length	Value	Scope
XX	1	Bit #0: effective CINR curve parameter reporting Bit #1: CINR time validity reporting. Bit #2: CINR CDF reporting	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

[Add the following entries to the end of the 2nd table in section 11.11 (REP-REQ)]

Name	Type	length	values
channel selectivity report	2	1	Bit #0: if 1, include CINR CDF samples Bit #1: if 1, include CINR time validity Bit #2: if 1, include frequency selectivity report Bits #3-6: number of CINR samples used for CINR CDF, calculated as $2^{(n+4)}$, where n = bit#3-6 Bit#7: reserved, shall be set to zero

[Add the following tables at the end of section 11.12]

REP-REQ Channel selectivity report	Name	Type	Length	Value
OFDMA PHY	Frequency Selectivity Report	2.1	4	Bit #0~7: a Bit #8~15: b Bit #16~23: c Bit #24~31: CINR when *a*, *b*, and *c* were determined
OFDMA PHY	Time Selectivity Report	2.2	1, 3, or 4	If length = 1, Bit #0~7: CINR time validity If length = 3, Bit #0~7: CINR CDF 60% point Bit #8~15: CINR CDF 15% point Bit #16~23: CINR CDF 5% point If length = 4,

		Bit #0~7: CINR CDF 60% point Bit #8~15: CINR CDF 15% point Bit #16~23: CINR CDF 5% point Bit #24~31: CINR time validity

For the TLVs with type 2.1and 2.2, the following 8 bit CINR encoding shall be used:

$$Payload\ bits = \begin{cases} 0, & CINR \le -6\text{ dB} \\ n, & (\frac{n-48}{8}) < CINR \le (\frac{n-47}{8}), \quad 0 < n < 255 \\ 255, & CINR > 26\text{ dB} \end{cases}$$

For the TLV with type 2.1, the following 8 bit encoding shall be used for a, b and c:
If the decimal value of the 8 bit field is n, then the numerical value of the parameter a is encoded as $\frac{n}{8} - 5$, the numerical value of the parameter b is encoded as $\frac{n}{128} - 0.5$, and the numerical value of the parameter c is encoded as $\frac{n}{512} - 0.4$.

For the TLV with type 2.2, the following 8 bit CINR time validity encoding shall be used:
00000000: CINR time validity < 1 frame,
00000001: 1 <= CINR time validity < 2 frames,
…
11111111: 255 <= CINR time validity.

3 Accuracy of the EESM method

The accuracy of the EESM modeling technique as a predictor for the AWGN-equivalent SINR was analyzed in [1].

4 References

[1] "CINR measurements using the EESM method", IEEE C802.16e-05/141r2.