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Abstract	
Purpose	
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CINR Reports For OFDMA PHY

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1 Problem Statement

The current draft defines two mechanisms that can be used for rate adaptation: average CINR reports and preferred-DIUC reports. Both mechanisms are incomplete and lack some important definitions.

CINR reports:

1. The text does not specify to what the CINR measurement relates. Measurements on the preamble, on pilots, and even on data subcarriers of different zones, will result in different values due to varying boosting levels, cell loading, and reuse factor. Further, when adaptive beamforming is employed, CINR measurements will vary greatly depending on the allocation used for measurement.

   The BS should specify the unique zone (by means of zone type and PRBS_ID in order to differentiate between multiple zones), and subset of major groups (for PUSC reuse-1 zone) on which the MS shall measure average CINR. Specifying the subset of major groups is important since different major groups may be transmitted with different power level or antenna beam (for example with 'dedicated pilot mode').

2. The text states that CINR is measured on "messages". It is not clear to which "messages" the text refers, as the MS is not required to decode or be aware of all messages in the frame. Further, the time scale of the message time indices is not defined; as a result, the averaging parameter has no meaning.

3. The text should specify that the CINR measurement should refer to non-boosted data subcarriers; hence the boost level of the preamble and pilots should be compensated for.

4. CINR estimates derived for CQICH should be kept distinct from reports triggered by REP-REQ/RSP. For example, we would want the ability to configure the CQICH to periodically report CINR on a specific zone, while triggering a one-time measurement on a different zone using REP-REQ/RSP.

Preferred-DIUC reports:

1. In a well-designed system, the error rate for reception of channel quality reports must be much lower than that of data (which may use H-ARQ for instance). The CQI mechanism is a very robust transport designed exactly for this purpose. However, reporting of the preferred MCS is only possible through a feedback header which itself uses regular MCS levels. This should also be possible through CQI.

2. DIUC does not include repetition-coding indication; hence preferred repetition coding level cannot be reported.

3. A preferred MCS must pertain to a specific target error rate, which differs between applications (low-latency voice, data with ARQ or H-ARQ, etc). Hence, the BS must specify the target error rate for which the preferred MCS shall be reported.

4. The MS should be instructed to trigger a non-periodic update of preferred-MCS in case the CQI interval is very large, otherwise consecutive downlink transmissions will fail for the duration remaining until the next CQI report arrives at the BS. This is especially important in applications that do not employ ARQ.

The following is an outline of the proposed changes:

1. A new subsection (6.3.23) is introduced to define the operation flow for CINR and preferred-MCS reports based on periodic CQI and non-periodic REP-REQ/RSP messages.

2. The CQICH_Alloc_IE is extended to include report configuration parameters (CINR-specific and preferred-MCS specific parameters).

3. The “preferred-DIUC” feedback type is extended to include repetition-coding level and to support CQI triggered update.

4. Preferred MCS report should correspond to a prescribed MCS reporting profile that defines the target block error rate (and assumed block size) for which the best MCS is to be reported.

5. “Preferred MCS” encoding on the 6-bit CQI channel is defined.

6. REP-REQ/RSP TLVs are added to support the different CINR measurement and preferred-MCS modes.

2 Detailed Text Changes

[Add a new section 6.3.23]

6.3.23 CINR/preferred-MCS Report Operation

This section applies to OFDMA mode only. The MS transmits CINR/preferred-MCS reports using the REP-RSP MAC message or fast-feedback (CQICH) channel. The measurement can be performed on the preamble or on a permutation zone. CINR measurement for a permutation zone can be done with pilots or data subcarriers. The MS shall implement at least one measurement scheme and negotiate its capability (refer to 11.8.3.7).

The UCD message defines multiple 'preferred-MCS reporting profiles', which define a target block error rate and assumed block length for that error rate. The BS may request a preferred-MCS report from the MS for a specific preferred-MCS reporting profile, in which case the MS shall respond with the DIUC and repetition code with which the expected block error rate, with blocks of the specified length, is closest to, but does not exceed, the target average error rate specified by the BS. When HARQ is employed, the computed block error rate shall only pertain to the first H-ARQ transmission.

6.3.23.1 CINR/preferred-MCS report with REP-RSP MAC message

The REP-RSP message shall be sent by the MS in response to a REP-REQ message from the BS to report estimation of DL CINR or preferred MCS.

For CINR/ preferred MCS reports, REP-REQ may indicate where the measurement shall be performed: preamble or a specific permutation zone. For the measurement on the preamble, BS can request MS to report the CINR/preferred MCS based on the measurement from the preamble for the different frequency reuse factors or band AMC configuration. For measurement on a specific permutation zone, the REP-REQ indicates the measurement type configuration, which includes the zone for which the CINR/preferred MCS is to be estimated. The zone is identified by its STC and permutation type (PUSC with 'use all SC=0', PUSC with 'use all SC=1', FUSC, Optional FUSC, AMC AAS zone, Safety channel), and PRBS ID. The MS shall not perform a measurement in a frame in which the specified zone is not allocated, and shall retain the previous measurement. For PUSC permutation zones , the MS may be instructed to report CINR/preferred MCS estimate for only a subset of the major groups. The MS may send a REP-RSP message in an unsolicited fashion.

In the case where the requested report configuration does not differ from the previous REP-REQ message in which CINR/preferred-MCS report was requested, the MS is required to send its response within 3 frames. A REP-REQ message shall not contain more than one TLV requesting any type of CINR or preferred-MCS report.

6.3.23.2 Periodic CINR/preferred-MCS report with fast-feedback (CQICH) channel

As soon as the BS and the SS know the capabilities of both entities modulation and coding, the BS may allocate a CQICH subchannel using a CQICH Allocation IE for periodic CINR or preferred-MCS reports.

For CINR reports, CQICH Allocation IE may indicate on what portion of the signal the measurement shall be performed: preamble or a specific permutation zone. For preferred-MCS reports, measurements shall be performed on a specific permutation zone. For the measurement on the preamble, BS can request MS to report the CINR/preferred MCS based on the measurement from the preamble for the different frequency reuse factors or band AMC configuration. For the measurement on the specific permutation zones, the CQICH Allocation IE indicates the measurement type configuration, which includes the zone for which the CINR/preferred-MCS is to be estimated. The zone is identified by its STC and permutation type (PUSC with 'use all SC=0', PUSC with 'use all SC=1', AMC AAS zone, FUSC, Optional FUSC, Safety channel), and PRBS ID. The MS shall not perform a measurement in a frame in which the specified zone is not allocated, and shall retain the previous measurement. For PUSC permutation zones , the MS may be instructed to report an estimate for only a subset of the major groups. The first CQICH Allocation IE sent to the MS shall indicate the measurement type configuration. Only a subsequent CQICH Allocation IE may update the measurement type configuration for CQI channel based reports. See sections 8.4.5.4.12, 8.4.5.4.15, and 8.4.11. The CINR/preferred MCS measurement encoding and quantization onto the Fast-Feedback channel is defined in section 8.4.5.4.10.

A preferred-MCS reported on the CQI is interpreted as the MS's recommendation as to the DIUC + repetition code which best meets the specified target error rate for the duration remaining until the next scheduled CQI report.

The MS shall send an unsolicited feedback header, with feedback type 0b0011, if it decides that the last recommended MCS is no longer appropriate for the duration remaining until the next periodic CQI transmission. The feedback header is used to specify the new preferred MCS for the CQI channel. The CQI channel is identified by its CQICH_ID. The MS shall not send an unsolicited update to the preferred-MCS of a CQI channel if 'triggered update' is disabled in the CQICH_Alloc_IE that allocated the CQI channel.

An MS shall be able to maintain 2 concurrent CQI channels (not necessarily being scheduled in the same frame) for preferred-MCS reports, both of which refer to the same zone but with a different preferred-MCS reporting profile. TheCQI channel is identified by the CQICH_ID field in the CQICH Allocation IE.

For the differential CINR report of Band AMC mode, a separate procedure is defined for the report configuration change in section 6.3.17.4. Further, the preferred MCS level report scheme shall not be used for Band AMC mode.

[Correct editorial errors on page 347 lines 9-18:]

~~8.4.5.4.12 CQICH Allocation IE format~~
8.4.5.4.14 UL-MAP Physical Modifier IE
[Modify table ~~300~~ 302 as indicated:]
Table ~~300~~ 302 – OFDMA UL-MAP Physical Modifier IE format

[Add the following entries to table 300 (CQICH_Alloc_IE), immediately before the 'Padding' field]

Syntax	Size	Notes
…		
CINR type included	1 bit	
If (CINR type included=1){		
Feedback Type	1 bits	0 : CINR feedback 1 : Preferred-MCS feedback
If (Feedback Type = 1){		
Preferred-MCS reporting profile index	2 bits	Index of preferred MCS reporting profile, as defined in the UCD message.
}		
CINR type	1 bit	0: CINR measurement from preamble (refer to 8.4.11.3) 1: CINR measurement from permutation zones (refer to 8.4.11.3)
If (CINR type=0) {		CINR measurement from preamble
Report type	1 bit	The report type of CINR estimate measured from preamble 0b 0 – Frequency reuse factor=1 configuration. 0b 1 – Frequency reuse factor=3 configuration.
}		
else {		CINR measurement from permutation zones
Report type	1 bit	0: CINR measurement from pilot subcarriers (refer to 8.4.11.3) 1: CINR measurement from data subcarriers (refer to 8.4.11.3)
Zone type	3 bits	The type of zone over which CINR is to be reported 0b 000 – PUSC with 'use all SC = 0' 0b 001 – PUSC with 'use all SC = 1' 0b 010 – FUSC 0b 011 – Optional FUSC 0b 100 – Safety Channel region 0b 101 – AAS zone 0b 110-111 – Reserved
Zone PRBS_ID	2 bits	The PRBS_ID of the zone over which CINR is to be reported
If ((Zone type =0b 001) or (Zone type = 0b101 and zone permutation = PUSC)) {		
PUSC Major group config indication	1 bit	If '0' then CINR report may refer to any subchannels in the PUSC zone.
If (Major group config indication=1) {		
PUSC Major group bitmap	6 bits	Reported CINR shall only be estimated for the subchannels of PUSC major groups for which the corresponding bit is set. Bit #*k* refers to major group *k*.
}		

}		
}		
}		
Averaging parameter included	1 bit	
If (Averaging parameter included = 1) {		
Averaging parameter	4 bits	Averaging parameter $_{avg}$ used for deriving CINR estimates reported through CQICH. This value is in multiples of 1/16 ranging [1/16,16/16] in increasing order.
}		

[Add the following text to the end of 8.4.5.4.12]

CINR type included
Indicates whether an update to the CQI report configuration exists in the IE. A value of '0' indicates that the SS shall perform CINR measurements using the latest received CQI configuration.

Feedback Type
Indicates which kinds of feedback shall be reported through the assigned CQICH. The estimate of CINR shall be reported ('0'), The preferred MCS level shall be reported ('1').

Preferred MCS reporting profile
The reporting profile to be used for determining the preferred MCS to be transmitted on the CQI channel. See section 6.3.23.

CINR type
Indicates where the CQI report shall be measured. SS can measure the estimation of the CINR from the preamble ('0') or the permutation zone indicated ('1').

Averaging parameter included
Indicate whether a new averaging parameter $_{avg}$ exists in the IE. A value of '0' indicates that the SS shall perform CINR measurements using the latest received averaging parameter.

[Add new section 8.4.5.4.10.14]

8.4.5.4.10.14 Preferred-MCS feedback for enhanced fast-feedback channel

This mode only applies to the enhanced 6-bit fast-feedback channel. When the feedback type field in the CQICH_Alloc_IE() is '1', the MS shall report the preferred MCS using the following 5-bit encoding:

Table 198u – Preferred-MCS feedback encoding

Payload bit encoding	Meanging
0-11	preferred DIUC, according to the burst profile encodings in the latest DCD message. The encoded value corresponds to the preferred DIUC. It shall be assumed that no repetition encoding is adopted.
12~14	Preferred repetition encoding for the 1st DIUC with QPSK modulation. 12: Repetition coding of 2 used for the DIUC and the DIUC is preferred 13: Repetition coding of 4 used for the DIUC and the DIUC is preferred 14: Repetition coding of 6 used for the DIUC and the DIUC is preferred
15~17	Preferred repetition encoding for the 2nd DIUC with QPSK modulation. 15: Repetition coding of 2 used for the DIUC and the DIUC is preferred 16: Repetition coding of 4 used for the DIUC and the DIUC is preferred 17: Repetition coding of 6 used for the DIUC and the DIUC is preferred
18~20	Preferred repetition encoding for the 3rd DIUC with QPSK modulation. 18: Repetition coding of 2 used for the DIUC and the DIUC is preferred 19: Repetition coding of 4 used for the DIUC and the DIUC is preferred 20: Repetition coding of 6 used for the DIUC and the DIUC is preferred
21~23	Preferred repetition encoding for the 4th DIUC with QPSK modulation. 21: Repetition coding of 2 used for the DIUC and the DIUC is preferred 22: Repetition coding of 4 used for the DIUC and the DIUC is preferred 23: Repetition coding of 6 used for the DIUC and the DIUC is preferred
24~26	Preferred repetition encoding for the 5th DIUC with QPSK modulation. 24: Repetition coding of 2 used for the DIUC and the DIUC is preferred 25: Repetition coding of 4 used for the DIUC and the DIUC is preferred 26: Repetition coding of 6 used for the DIUC and the DIUC is preferred
27~29	Preferred repetition encoding for the 6th DIUC with QPSK modulation. 27: Repetition coding of 2 used for the DIUC and the DIUC is preferred 28: Repetition coding of 4 used for the DIUC and the DIUC is preferred 29: Repetition coding of 6 used for the DIUC and the DIUC is preferred
30	DCD count changed.
31	Reserved

The n-th DIUC is determined as follows: 1)choose the DIUC whose modulation scheme is QPSK. 2) re-arrange DIUC in the increasing order of the DIUC values 3) the n-th DIUC means the n-th element of the set made from procedure 2).

If the 'DCD count' field in the DL-MAP of the frame in which the CQI is to be transmitted is different from the value of that field in the DCD message in which the DIUC profile was defined, then the MS shall transmit the 6-bit encoding 0b011110 instead of the preferred MCS.

[Modify the text in section 8.4.11.3 as follows]

When CINR measurements are mandated by the BS, an SS shall obtain a CINR measurement (implementation-specific). From a succession of these measurements, the SS shall derive and update estimates of the mean and/or the standard deviation of the CINR, and report them via REP-RSP messages and/or report the estimate of the mean of the CINR via the fast-feedback channel (CQICH).

Mean and standard deviation statistics for CINR shall be reported in units of dB. To prepare such reports, statistics shall be quantized in 1 dB increments, ranging from a minimum of –10 dB (encoded 0x00) to a maximum of 53 dB (encoded 0x3F). Values outside this range shall be assigned the closest extreme value within the scale.

The method used to estimate the CINR of a single message is left to individual implementation, but the relative and absolute accuracy of a CINR measurement derived from a single message shall be ±1 dB and ±2 dB, respectively. The specified accuracy shall apply to the range of CINR values starting from 3 dB below SNR of the most robust rate, to 10 dB above the SNR of the least robust rate. See Table 336. In addition, the range over which these single-packet measurements are measured should extend 3 dB on each side beyond the –10 dB to 53 dB limits for the final reported, averaged statistics.

If CINR report from the preamble was instructed, then the reported CINR shall be an estimate of the CINR over the subcarriers of the preamble. For the frequency reuse configuration=3 type, the reported CINR shall be the estimate of the CINR over the modulated subcarriers of the preamble. For the frequency reuse configuration=1, the reported CINR shall be the estimate of the average CINR over all subcarriers of the preamble except the guard subcarriers and the DC subcarriers. In other words, the signal on the unmodulated subcarriers (except the guard subcarriers and the DC subcarriers) shall also be considered as noise and interference for the CINR estimate of the frequency reuse configuration=1. The reported value shall represent the average CINR on non-boosted data subcarriers of the first zone in the frame; hence preamble boosting shall be compensated for in both desired signal and interference + noise calculation.

In case CINR report on specific permutation zone was instructed, then the reported CINR shall be an estimate of the average CINR over the pilot or data subcarriers, as instructed by the BS. The reported value shall represent the average CINR on non-boosted data subcarriers of the zone on which measurement was requested; hence pilot boosting shall be compensated for in both desired signal and interference + noise calculation.

If the BS instructs CINR reporting on an AAS zone with AMC permutation, then the MS shall report the estimate of the CINR on pilot or data subcarriers that belong to slots allocated to it. In case CINR reporting on STC zone is instructed, the MS shall report the average post-combined CINR.

[Add the following text at the end of section 8.4.11.3]

The averaging parameter ($_{avg}$) may be sent as a DCD message TLV. Unless specified otherwise, the default averaging parameter ($_{avg}$) is ¼. When the averaging parameter ($_{avg}$) is given to an MS through REP-REQ, this value shall only be used for deriving CINR estimates reported through REP-RSP, and can further only be changed through another REP-REQ message. When the averaging parameter is given to a MS through CQICH_Allocation_IE, this value shall only be used for deriving CINR estimates reported through fast-feedback channel (CQICH), and can further only be changed through another CQICH Allocation IE. An averaging parameter value sent through DCD shall not override the averaging parameter value sent in a dedicated REP-REQ message or a CQICH Allocation IE.

[Add the following entry to the end of table 353, section 11.3.1]

Preferred-MCS reporting profiles	ZZZ	4	Each byte corresponds to a reporting profile, starting from reporting profile #0, with the following structure: Bits #0-#2: (=n) Target block error rate, defined as $2^{(-n-2)}$ Bits #3-#6: (=k) Target block length for computing block error rate, defined as 60*(k+1), in units of bytes. Bit #7: *Reserved*

[Add the following entry to the end of table 358, section 11.4.1]

Default RSSI and CINR averaging parameter	ZZZ	1	Bit #0~3: Default averaging parameter $_{avg}$ for CINR measurements, in multiples of 1/16 (range [1/16, 16/16], 0x0 for 1/16, 0xF for 16/16). Bit #4-#7: Default averaging parameter $_{avg}$ for RSSI measurements, in multiples of 1/16 (range [1/16, 16/16], 0x0 for 1/16, 0xF for 16/16).	OFDMA

[Add the following new section]

11.8.3.7.X OFDMA SS CINR/preferred-MCS measurement capability

[Add the table as follows at pp.135, line 27]

Type	Length	Value	Scope
XXX	1	Bit #0: CINR measurement from the preamble Bit #1: CINR measurement for a permutation zone from pilot subcarriers Bit #2: CINR measurement for a permutation zone from data subcarriers Bit #3: Preferred-MCS reports 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 to the 2nd table in section 11.11 (REP-REQ) of 802.16-2004 as follows]

11.11 REP-REQ management message encodings

Zone-specific CINR request	1.4	3	Bits #0-2: Type of zone on which CINR is to be reported 0b000: PUSC zone with 'use all SC=0' 0b001: PUSC zone with 'use all SC=1' / PUSC AAS zone 0b010: FUSC zone 0b011: Optional FUSC zone 0b100: Safety Channel region 0b101: AMC AAS zone 0b110 - 0b111: *Reserved* Bit #3: 1 if zone for which CINR should be estimated is STC zone, 0 otherwise. Bits #4-5 : PRBS_ID of the zone for which CINR should be estimated. Ignored for Safety Channel. Bit #6: data/pilot-based CINR measurement: 0 - Report the CINR estimate from pilot subcarriers, 1 - Report the CINR estimate from data subcarriers Bits #7-12 : Reported CINR shall only be estimated for the subchannels of PUSC major groups for which the corresponding bit is set. Bit #(*k*+7) refers to major group *k*. Only applicable for CINR measurement on a PUSC zone Bits #13-16: Δ_{avg} in multiples of 1/16 (range is [1/16,16/16]) Bits #17: 0: report the CINR, 1:*report the preferred MCS* Bits #18-23: *reserved*
Preamble CINR request	1.5	1	Bits #0-1: Type of preamble CINR measurement 0b00 - Report the estimation of CINR measured from preamble for frequency reuse configuration=1 0b01 - Report the estimation of CINR measured from preamble for frequency reuse configuration=3 0b10 - Report the estimation of CINR measured from preamble for band AMC 0b11 - *Reserved* Bits #2-5: Δ_{avg} in multiples of 1/16 (range is [1/16,16/16]) Bit #6: 0: report the CINR, 1:*report the preferred MCS* Bit #7: Reserved (shall be set to zero)

[Add the following tables at the end of 11.12]

REP-REQ Zone-specific CINR request	Name	Type	Length	Value
Bits #0-2 = 0b000	PUSC zone with 'use all SC=0'	2.1	1	Bit #0-4: CINR estimate for PUSC zone with 'use all SC=0' and PRBS_ID indicated in 'zone-specific CINR request'. Encoding is defined in 8.4.5.4.10.5 or (8.4.5.4.10.14). Bit #5: Report type: 0 - CINR estimated from pilot subcarriers, 1- CINR estimated from data subcarriers Bit #6-7: reserved
Bits #0-2 = 0b001	PUSC zone with 'use all SC=1' / PUSC AAS zone	2.2	1	Bit #0-4: CINR estimate for PUSC zone with 'use all SC=1' (or PUSC AAS zone) and PRBS_ID indicated in 'zone-specific CINR request'. CINR reported corresponds to a subset of major groups as specified in 'CINR type request'. Encoding is defined in 8.4.5.4.10.5 or (8.4.5.4.10.14). Bit #5: Report type: 0 - CINR estimated from pilot subcarriers, 1- CINR estimated from data subcarriers Bit #6-7: reserved

Bits #0-2 = 0b010	FUSC zone	2.3	1	Bit #0-4: CINR estimate for FUSC zone with PRBS_ID indicated in 'zone-specific CINR request'. Encoding is defined in 8.4.5.4.10.5. Bit #5: Report type: 0 - CINR estimated from pilot subcarriers, 1- CINR estimated from data subcarriers Bit #6-7: reserved
Bits #0-2 = 0b011	Optional FUSC zone	2.4	1	Bit #0~4: CINR estimate for Optional FUSC with PRBS_ID indicated in 'zone-specific CINR request'. Encoding is defined in 8.4.5.4.10.5 or (8.4.5.4.10.14). Bit #5: Report type: 0 - CINR estimated from pilot subcarriers, 1- CINR estimated from data subcarriers Bit #6-7: reserved
Bits #0-2 = 0b100	Safety channel	2.5	5	The first 20 bits for the reported bin indices and the next 20 bits for CINR reports (5 bits for each bin). CINR encoding is defined in 8.4.5.4.10.5 or (8.4.5.4.10.14).
Bits #0-2 = 0b101	AMC AAS zone	2.6	1	Bit #0~4: CINR estimate for AMC AAS zone. Encoding is defined in 8.4.5.4.10.5 or (8.4.5.4.10.14). Bit #5: Report type: 0 - CINR estimated from pilot subcarriers, 1- CINR estimated from data subcarriers Bit #6-7: reserved

[Add the following tables at the end of 11.12]

REP-REQ Preamble CINR request	Name	Type	Length	Value
Bits #0-1 = 0b00	The estimation of CINR measured from preamble for frequency reuse configuration=1	3.1	1	Bit #0~4: The estimation of CINR measured from preamble for frequency reuse configuration=1. Encoding is defined in 8.4.5.4.10.5 or (8.4.5.4.10.14).. Bit #5~7: reserved.
Bits #0-1 = 0b01	The estimation of CINR measured from preamble for frequency reuse configuration=3	3.2	1	Bit #0~4: The estimation of CINR measured from preamble for frequency reuse configuration=3. Encoding is defined in 8.4.5.4.10.5 or (8.4.5.4.10.14).. Bit #5~7: reserved.
Bits #0-1 = 0b10	The estimation of CINR measured from preamble for Band AMC zone.	3.3	4	The estimation of CINR measured from preamble for band AMC subchannel. First 12 bits for the band indicating bitmap and Next 20 bits for CINR reports (5 bits per each band). CINR encoding is defined in 8.4.5.4.10.5 or (8.4.5.4.10.14).