

DL Burst profile selection unsuitable for OFDMA

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1. Motivation

The current mechanism of DL burst profile control is based on DIUC entry and exit values (CINR 0-63dB) that appear in the DCD (p.668, lines 54-63). The SS should send a DBPC-REQ (see 6.3.2.3.20, 6.3.10.1) with the preferred DIUC each time the CINR is outside the allowed value for currently used DIUC. This mechanism is not suitable for OFDMA (and in some senses for OFDM) because of several reasons, mainly the existence of multiplicity of modulation parameters (code type and code rate, constellation, repetition, boosting, AAS, STC, permutation zones), who may have overlapping CINR ranges and cannot be controlled by the DBPC mechanism in its current form. This situation may cause deadlocks to occur when the SS asks for a certain burst profile dictated by CINR thresholds in the DCD while the BS chooses to ignore the request and enhance the transmission by means of repetition, boosting, etc. If the protocol is left in its current form, the SS may continuously send DBPC-REQ messages although its link is perfectly fine.

This issue may seem like a minor protocol problem, however correcting this mechanism is important, not only to prevent deadlock, but also to enable the gain of the advanced coding schemes and the multi-data-rate coding that exist in the standard.

2. Details

2.1. problems in the existing DBPC-REQ/RSP protocol

2.1.1. Choice of modulation scheme

The BS has a much broader choice of modulation scheme than simple choice of DIUC. The BS can enhance the transmission using repetition, boosting, AAS, STC, allocate a different subchannel to the SS if the specific subchannel suffers from interference, or move it to a different permutation zone (for example from reuse 1 FUSC to reuse 1/3 PUSC). The current mechanism leaves the burst profile selection algorithm in the SS, and allows it to select only DIUC, thus not allowing the BS to take full advantage of the modulation options.

Even had these controls been added to the DBPC-REQ message (control of repetition and boosting, for example), the SS cannot determine these values since the power constraints and scheduling restrictions are known only to the BS. In addition, since there are multiple coding schemes (CC/CTC/BTC) with potentially overlapping CINR ranges, the decision between coding schemes better be made in the BS.

2.1.2. Example of failure scenarios

2.1.2.1. No transition to QPSK rate 1/4

According to [C802.16e-04/16](#), QPSK rate 1/2 and rate 1/4 (2 repetitions) are most useful rates in deployments. However, current mechanism does not allow transition to rate 1/4, as shown by following example:

A user working in QPSK rate 1/2 falls below lower CINR threshold of QPSK rate 1/2. According to the standard, it should send DBPC-REQ asking for lower burst profile, however this lower burst profile has the same DIUC (only different repetition parameter), therefore the SS cannot cause the BS to transition to rate 1/4 using this mechanism.

2.1.2.2. No way to turn off the mechanism

A user works in 16QAM, rate 1/2, and falls below CINR threshold of this rate, must inform BS by transmitting DBPC-REQ. However, BS may choose boosting for this user. In this way, the average CINR will remain below threshold, and user must continue to send DBPC-REQ to BS, although there isn't an actual problem.

2.1.3. CINR threshold range

The threshold levels defined in the DCD support only positive CINR, whereas OFDMA can operate down to CINR=-6dB (for CTC QPSK rate 1/2 with repetition 6), and additional 9dB due to boosting (if CINR of preamble or average CINR is measured).

2.1.4. Interworking with FAST-FEEDBACK

BS can use the FAST-FEEDBACK or CQICH mechanisms to receive reports from the SS. However since DBPC-REQ is mandatory, the SS will continue sending reports to the BS even if FAST-FEEDBACK mechanism is activated.

2.1.5. CINR value not well defined

It is not defined what the CINR value relates to. Does it relate to data carriers of a specific burst, to data carriers overall, or to the pilots or to the preamble? different SS implementations may choose different sources to estimate CINR from resulting in large difference in the result:

- (1) Treatment of boosting: if the SS measures CINR directly on data subcarriers of specific DL bursts (directed to it) then boosting is taken into account. If it measures CINR overall then boosting (on average) is not included in the report.
- (2) Weighting of interference versus noise: since pilots and preambles are boosted (in 7dB and 2.5dB accordingly), then CINR resulting from noise is weighted differently than CINR resulting from interference. The standard doesn't define should an SS estimating CINR from pilots/preambles scale the result according to the pilots/preamble boosting or not, and this may result in difference of 7dB between SS. Even if normalization is defined, the problem with different weighting of noise and interference exists.
- (3) Taking partial collisions into account: The pilots/preamble and data subcarriers may suffer from interference from other BS, when there is a collision on that tone (=other BS uses same tone). This results in different C/I on pilots and data. For example, for BS that use the same RF channel and same PUSC segment, partial collisions occur on the data subcarriers (depending on the BS load), however all the pilots and the preamble tones are in collision (to will measure higher CINR). For BS with different PUSC segments, and different Cell-ID (in the permutation), there is no interference on preamble tones, partial interference on pilots and data tones. To conclude, different measurement methods will give completely different results, depending on the deployment.

2.2. Suggested remedy

We suggest to define that DBPC-REQ mechanism is not applied to OFDMA and remove threshold values from DCD.

In order to allow a SS that needs a more robust burst profile and doesn't have a CQICH channel allocated inform the BS of state, we suggest to use the REP-RSP message.

The conditions for the SS to initiate such a transmission should be defined. Also, the definition of CINR or S/N for all feedback modes is missing.

3. Changes summary

6.3.10.1 Downlink burst profile management

[Add the following sentence at the end of p.202]

This mechanism is not applicable to OFDMA PHY. SS may use unsolicited REP-RSP message to report CINR to the BS.

11.4.2 Downlink burst profile encodings

[Remove lines 56-62 (DIUC Mandatory exit threshold, DIUC Minimum entry threshold)]