TSG-RAN Working Group 1 meeting #7bis
Kyongju, South Korea
October 4 – October 5, 1999

TSGR1#7bis(99)e85

Agenda item:

Source: Ericsson

Title: Setting of uplink DPCCH and DPDCH power difference

Document for: Decision

---

1 Introduction

The gain factors (beta-values) for the uplink DPDCH and DPCCH channels are specified in [1]. Up to now, the method for determining the gain factors has not been specified. Further, similar gain factors should be used also for the PRACH message part. This contribution addresses these points.

2 General idea

Since each TFC (Transport Format Combination) typically has a unique data rate, it is reasonable that each TFC is connected with a unique pair of gain factors for the DPCCH and the DPDCH. For a TFC with high bit rate the power difference should be larger between DPDCH and DPCCH, then for the case with a TFC with low bit rate.

The obvious way of assigning gain factors to the TFCs is to signal them. However, signalling can be reduced if a reference TFC is defined with corresponding gain factors, and other TFCs set their gain factors based on the difference in bit rate compared with the reference TFC.

The change of gain factors for DPDCH and DPCCH should be performed such that the transmitted E_b (before coding) on the DPDCH is kept constant independent on the rate of data while the DPCCH power should be kept constant such that the power control is not affected. Both these properties are very important, otherwise the quality of the system will be degraded. If the ratio in power between DPCCH and DPDCH is wrong the power control loop which is working on DPCCH has the wrong SIR target which it is trying to achieve. This leads either to a degraded performance on the DPDCH because the E_b is decreased compared with previous slots or to a good quality on the DPDCH but at a unnecessarily high power level which increases the interference on other channels.

3 Computation of gain factors

One solution for adjusting the gain factors could be to adjust it with the bit rate of the transport channels. It works good when all transport channels have the same coding rate and rate matching parameters. But it does not work fine with different coding rates. When the data rate of a transport channel that has a low coding rate varies, it has a larger impact on the power of the DPDCH than when the data rate of an uncoded transport channel varies. Therefore both coding rate and rate matching parameters must be taken into account. However, the power should be based on information describing the data rate before the rate matching is performed, otherwise only the spreading factor is taken into account because the entire frames in uplink are filled up after the rate matching.

The rate matching algorithm has the property that the channel bit rate and thereby the power setting of <u>each</u> transport channel is proportional to the sum

$$\sum_i RM_i \cdot N_i \ ,$$

where where RM_i is the semi-static rate matching attribute for transport channel *i* (defined in TS 25.212 section 4.2.7), N_i is the number of bits output from the radio frame segmentation block for transport channel *i* (defined in TS 25.212 section 4.2.6.1), and the sum is taken over all the transport channels *i* in the reference TFC.

When this information is used for the gain factors of the DPDCH and the DPCCH the code rate and the rate matching parameters for the different transport channels are taken into account but it is before the rate matching is performed.

The gain factors of the current frame must be related to a reference TFC where the gain factors were signalled. Since the change shall be proportional to the parameters indicated above the amplitude ratio for the actual frame should be according Eq 1.

$$\frac{b_{d,current}}{b_{c,current}} \geq \frac{b_{,reference}}{b_{,reference}} \cdot \sqrt{\frac{\left[\sum_i RM_i \cdot N_i\right]_{current}}{\left[\sum_i RM_i \cdot N_i\right]_{reference}}} \qquad \text{(Eq. 1)}$$

The b-values should be quantified to the value that gives the next higher amplitude ratio. Since one of the b -values always is 1.0, the values are always well defined. If b_d is 1.0, b_c shall be quantized downwards, and if b_c is 1.0 b_d shall be quantized to the next higher value.

4 Overall power setting

Note that in the baseband part of the terminal the gain factors controls the relative amplitudes of DPCCH and DPDCH, while the total power is normally controlled in the radio parts. When the data rate is changed both the ratio between DPDCH and DPCCH as well as the output power is affected and both the ratio and the power level must therefore be adjusted.

The output power at the antenna connector, after the amplitude ratio is changed, shall always keep the DPCCH at the same power as the previous frame, except the inner loop power control step. There will therefore be a power step between the previous slot and the current slot, which is the first slot with the new rate matching.

$$P_{out,current} = \frac{1+\frac{b^2_{d,current}}{b^2_{c,current}}}{1+\frac{b^2_{d,previous}}{b^2_{c,previous}}} P_{out,previous} + TPC \qquad \text{(Eq. 2)}$$

where TPC means the power control step at the actual slot boundary. The actual step size and accuracy of this power step is according the requirements given in TS25.101, specified in TSG RAN WG4.

5 Conclusions

It is proposed that both direct signalling of gain factors and indirect signalling by using a reference TFC and comparison of the TFCs' bit rates shall be possible. Hence, what is proposed is that there are two ways of controlling the gain factors of the DPCCH code and the DPDCH codes for different TFCs:

- b_c and b_d are signalled for the TFC, or
- b_c and b_d is computed for the TFC, based on the signalled settings for a reference TFC.

Combinations of the two above methods may be used to associate b_c and b_d values to all TFCs in the TFCS. Several reference TFCs may be signalled from higher layers.

The same concepts may be applied both for uplink DPCCH/DPDCH and PRACH message control and data parts.

References

[1]. TSG RAN WG1, "Spreading and Modulation (FDD)", TS 25.213, V2.3.0

[2]. TSG RAN WG4, “UE Radio Transmission and Reception”, TS 25.101

Text proposal for TS 25.214 V1.3.1

5.1.1 PRACH

5.1.1.1 General

The transmitter power of UE shall be calculated by following equation:

$P_{RACH} = L_{Perch} + I_{BTS} +$ Constant value
where,
P_{RACH}: transmitter power level in dBm,
L_{Pearch}: measured path loss in dB,
I_{BTS}: interference signal power level at BTS in dBm, which is broadcasted on BCH,
Constant value: This value shall be designated via Layer 3 message (operator matter).

5.1.1.2 Setting of PRACH control and data part power difference

The message part of the uplink PRACH channel shall employ gain factors to control the control/data part relative power similar to the uplink dedicated physical channels. Hence, section 5.1.2.4 applies also for the RACH message part, with the differences that:

- b_c is the gain factor for the control part (similar to DPCCH),
- b_d is the gain factor for the data part (similar to DPDCH),
- no inner loop power control is performed.

5.1.2.4 Setting of the uplink DPCCH/DPDCH power difference

5.1.2.4.1 General

The uplink DPCCH and DPDCH(s) are transmitted on different codes as defined in section 4.2.1 of TS 25.213. The gain factors β_c and β_d may vary for each TFC. There are two ways of controlling the gain factors of the DPCCH code and the DPDCH codes for different TFCs:

– b_c and b_d are signalled for the TFC, or

– b_c and b_d is computed for the TFC, based on the signalled settings for a reference TFC.

Combinations of the two above methods may be used to associate b_c and b_d values to all TFCs in the TFCS. The two methods are described in sections 5.1.2.4.2 and 5.1.2.4.3 respectively. Several reference TFCs may be signalled from higher layers.

The gain factors may vary on radio frame basis depending on the current TFC used. Further, the setting of gain factors is independent of the inner loop power control. This means that at the start of a frame, the gain factors are determined and the inner loop power control step is applied on top of that.

Appropriate scaling of the output power shall be performed by the UE, so that the output DPCCH power follows the inner loop power control with power steps of $\pm\Delta_{TPC}$ dB.

5.1.2.4.2 Signalled gain factors

When the gain factors b_c and b_d are signalled by higher layers for a certain TFC, the signalled values are used directly for weighting of DPCCH and DPDCH(s).

5.1.2.4.3 Computed gain factors

The gain factors b_c and b_d may also be computed for certain TFCs, based on the signalled settings for a reference TFC.

Let $b_{c,ref}$ and $b_{d,ref}$ denote the signalled gain factors for the reference TFC. Further, let $b_{c,j}$ and $b_{d,j}$ denote the gain factors used for the TFC in the *j*:th radio frame.

Define the variable

$$K_{ref} = \sum_i RM_i \cdot N_i \text{,}$$

where RM_i is the semi-static rate matching attribute for transport channel *i* (defined in TS 25.212 section 4.2.7), N_i is the number of bits output from the radio frame segmentation block for transport channel *i* (defined in TS 25.212 section 4.2.6.1), and the sum is taken over all the transport channels *i* in the reference TFC.

Similarly, define the variable

$$K_j = \sum_i RM_i \cdot N_i \text{,}$$

where the sum is taken over all the transport channels *i* in the TFC used in the *j*:th frame.

The variable A_j is then computed as:

$$A_j = \frac{b_{d,ref}}{b_{c,ref}} \cdot \sqrt{\frac{K_j}{K_{ref}}} \text{.}$$

The gain factors for the TFC in the *j*:th radio frame are then computed as follows:

If $A_j > 1$, then $b_{d,j} = 1.0$ and $b_{c,j} = \lfloor 1/A_j \rfloor$, where $\lfloor \bullet \rfloor$ means rounding to closest lower quantized β-value.

If $A_j \le 1$, then $b_{d,j} = \lceil A_j \rceil$ and $b_{c,j} = 1.0$, where $\lceil \bullet \rceil$ means rounding to closest higher quantized β-value.

The quantized β-values are defined in TS 25.213 section 4.2.1, table 1.