

To: TSG RAN WG2
Cc: TSG RAN WG4
Source: TSG RAN WG1
Title: Liaison statement on Outer-loop power control in compressed mode

During the WG1#10 meeting, it was agreed to apply the puncturing method for compressed mode per TTI basis and to have two transmission gap lengths per transmission gap period (TGL1 and TGL2).

WG1 has also discussed the outer loop power control algorithm for compressed mode by puncturing. There has been two ideas on this issue:

1) Defining DeltaSIR parameters per TTI basis

In WG1#10 meeting there was a proposal (TSGR1#10(00)086) suggesting that a separate DeltaSIR parameter would be defined for each different TTI length in the CCTrCH, and in each frame the dominating TTI would drive the outer loop. This would however require quite a lot of restrictions to compressed mode parameters TGP and TGD since with this scheme it has to be ensured that for each TTI length in the CCTrCH, the puncturing percentage is always having constant value (or 0). This would of course restrict the usage of compressed mode by puncturing quite a lot.

2) Defining DeltaSIR parameters per frame basis

In WG1#11 there was a new proposal (TSGR1#11(00)262) on this issue, which proposes that it is not necessary to define separate DeltaSIR parameters for each different TTI length in the CCTrCH. The contribution is attached to this LS. The idea in this proposal is that outer loop works frame by frame basis. Thus the SIR target is increased only:

- in the frames that contain transmission gap
- possibly also in the recovery frame (=next frame after the compressed frame)

This scheme means that there does not have to be any restrictions for compressed mode parameters TGP and TGD, since now there is no requirement that the puncturing percentage is constant for the longest TTI in the CCTrCH in all TTIs during the connection.

If it is of any help to WG2, WG1 would like to pass the result of the discussion to WG2, that WG1 thinks that the method 2 is better, since it does not create any additional restrictions for the usage of compressed mode by puncturing.

WG1 is however aware that after RRM adhoc meeting in Turin, it is not yet clear whether these DeltaSIR parameters are signaled or not. That is left for the WG2 to decide.

There was also a question raised in WG1 that what if there are several simultaneous compressed mode patterns using puncturing method. Is it then allowed that these different patterns create a transmission gap within the same max TTI in the CCTrCH. Since if the

DeltaSIR parameters would be applied separately for each pattern, they cannot be simply added to each other. This is because DeltaSIR defines e.g. coding gain degradation due to puncturing, and up to certain percentage of puncturing, there is not yet any coding gain degradation. WG1 would like to get feedback for this issue from both WG2 and WG4, so that if needed, WG1 can define certain restrictions for the usage of simultaneous patterns by puncturing into 25.215.

Agenda Item: AH08
Source: Alcatel
Title: Outer-loop power control in compressed mode
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Introduction

In compressed mode by reducing the spreading factor by 2, the target SIR needs to be increased during compressed and recovery frames for two reasons:

- The instantaneous bit rate is increased during the compressed frame,
- Since the inner loop power control is no longer active during the transmission gaps, the performance is significantly degraded, mainly during compressed and recovery frames (frames following compressed frames)

Since the classical outer-loop power control algorithm is a slow process, an additional mechanism is required in compressed mode to change the target SIR during compressed and recovery frames. Such mechanism was proposed in [1], [2] and [3] and was accepted. Basically, two parameters are signalled with other compressed mode parameters (see RRC protocol specifications [4]):

- DeltaSIR: Delta in DL SIR target value to be set in the UE during the compressed frame (without including the effect of the change of bit rate).
- DeltaSIRafter: Delta in DL SIR target value to be set in the UE one frame after the compressed frames.

Then, during compressed mode, the UE increases the DL target SIR by ΔSIR where:

- $\Delta\text{SIR} = \text{DeltaSIR} + 3$ during the compressed frames
- $\Delta\text{SIR} = \text{DeltaSIRafter}$ during the recovery frames
- $\Delta\text{SIR} = 0$ for other frames

where TGL is the transmission gap length. The 3 dB offset aims to compensate for the bit rate increase. It does not need to be signalled from the UTRAN to the UE.

During the last WG1 meeting, it was agreed that the puncturing scheme be applied on a TTI by TTI basis (rather than on a frame by frame basis) as proposed in [5], since this enables to improve the performance. This requires that some modifications be done for the outer-loop power control algorithm in compressed mode. A first method was proposed in [5]. It proposes to signal a SIR target offset for each TTI length and thus up to four values.

However this algorithm has the following drawbacks:

- Many restrictions are required for the values of TGP, TGD and SFN. This limits the usage of the compressed mode by puncturing.
- The signalling is different from the one already agreed for compressed mode by reduction of the spreading factor. Thus two different signalling will have to be specified.

- When $TGL1 = TGL2$, up to four values need to be signalled whereas only two are required for compressed mode by reduction of the spreading factor.
- When $TGL1 \neq TGL2$, the same SIR target offset is signalled for the two transmission gaps which causes some problems since the performance degradation due to the inner-loop power control interruption and the puncturing rate depend significantly on TGL (see clause 5 of [5]). To avoid this problem, it would be necessary to signal different SIR target offsets for the two transmission gap lengths, i.e. up to 8 values, which represents quite a large amount of signalling.
- The target SIR increase is applied during the whole TTI whereas it is mainly needed during the compressed and recovery frames, which is therefore not optimal.

Therefore, we rather propose a simpler and more efficient approach, similar to the one used for compressed by reducing the spreading factor. It has the advantage to not require any restriction on SFN, TGP and TGD values.

The basic idea is that the performance degradation due to the interruption of inner-loop power control is only significant during compressed and recovery frames. Moreover, the degradation due to excessive puncturing is only significant for TTI of 10 and 20 ms and is negligible otherwise (since $TGL \leq 7$, the puncturing rate is lower than $7/(15 \cdot F)$ where F is the number of frames in the TTI). Therefore, we only need to signal the SIR target increase that is required in compressed and recovery frames, whatever the compressed method is (and not in all the TTI as proposed in [5]). This method was performed efficiently in [3] for compressed mode by reduction of the spreading factor by 2.

Proposed algorithm

Two values ΔSIR and ΔSIR_{after} are signalled by the UTRAN to the UE (as it is currently specified).

For each frame, the target SIR offset during compressed mode, compared to normal mode is:

$$\Delta SIR = \max(\Delta SIR_{1_compression}, \dots, \Delta SIR_{n_compression}) + \Delta SIR_{coding}$$

where n is the number of TTI lengths for all TrChs of the CCTrCh, F_i is the length in number of frames of the i -th TTI and where ΔSIR_{coding} fulfills:

- $\Delta SIR_{coding} = \Delta SIR$ for compressed frames.
- $\Delta SIR_{coding} = \Delta SIR_{after}$ for recovery frames.
- $\Delta SIR_{coding} = 0$ otherwise.

and $\Delta SIR_{i_compression}$ is defined by :

- If the frames are compressed by reducing the spreading factor by 2:
 - $\Delta SIR_{i_compression} = 3$ dB for each compressed frame, where TGL is the gap length in number of slots (either from one gap or a sum of gaps) in the frame.
 - $\Delta SIR_{i_compression} = 0$ otherwise.
- If the frames are compressed by puncturing:
 - $\Delta SIR_{i_compression} = 10 \log(15 \cdot F_i / (15 \cdot F_i - TGL_i))$ if there is a transmission gap within the current TTI of length F_i frames, where TGL_i is the gap length in number of slots (either from one gap or a sum of gaps) in the current TTI of length F_i frames.
 - $\Delta SIR_{i_compression} = 0$ otherwise.

ΔSIR_i compression aims to compensate for the increase bit rate during the compressed frames whereas $\Delta\text{SIR}_{\text{coding}}$ aims to compensate for the performance degradation due to excessive puncturing and interruption of the inner-loop power control during the transmission gap.

In the particular case where the transmission gap overlaps two frames (double-frame method), the second compressed frame (with the second part of the transmission gap) must be considered as the recovery frame ($\Delta\text{SIR}_{\text{coding}} = \text{DeltaSIRafter}$). Thus, in this case, the first frame following the two consecutive compressed frames is not considered as a recovery frame ($\Delta\text{SIR}_{\text{coding}}=0$). This enables to have different offset values for the first and second part of the transmission gap, knowing that no significant SIR target increase is needed in the first frame following the two consecutive compressed frames.

Since several compressed mode patterns may be used simultaneously, it may happen that several target SIR offsets from different compressed mode patterns apply to the same frame. In this case, all offsets must be added and the total target SIR offset is applied to the frame (as in proposal [5]).

Furthermore, during the last meeting it was proposed that two values of TGL are possible in each compressed mode pattern. If this is accepted, we propose that different values of DeltaSIR and DeltaSIRafter be signalled for each value of TGL:

- DeltaSIR1 and deltaSIRafter1 to be applied respectively for the compressed and recovery frames of the first transmission gap of length TGL1
- DeltaSIR2 and deltaSIRafter2 to be applied respectively for the compressed and recovery frames of the first transmission gap of length TGL2

Conclusion

Compared to the proposal in [5], The advantages of this proposal are:

- No restriction is required on TGP, TGD and SFN.
- The same signalling is done whatever the compressed mode (by reduction of the spreading factor or by puncturing)
- When $\text{TGL1} = \text{TGL2}$, only two values (DeltaSIR and DeltaSIRafter) are needed compared to up to four values with the proposal in [5].
- When $\text{TGL1} \neq \text{TGL2}$, only four values are required to have different SIR target offsets for the two transmission gaps compared to up to eight with the proposal in [5].
- The target SIR is only increased in frames where it is needed and not always in the whole TTI

If this proposal is agreed, we suggest that a liaison statement be sent to RAN WG2 on this issue so that the algorithm is specified in WG2.

References

[1] 3GPP TSGR1#6(99)956, "Improvement of outer-loop power control in compressed mode", July 1999, Alcatel

[2] 3GPP TSGR2#6(99)806, "Improvement of outer-loop power control in compressed mode", August 1999, Alcatel

[3] 3GPP TSGR1#7(99)c05, "Simulation results for outer-loop power control in compressed mode", August 1999, Alcatel

[4] 3GPP TS 25.331, "RRC protocol specifications"

[5] 3GPP TSGR1#10(00)86, "CR25.215-023rev1: Compressed mode by puncturing issues (revision)", Nokia