TSG-RAN Working Group1 meeting #11 TSGR1#11(00)0357

San Diego, CA, U.S.A., February 29 – March 3, 2000

Agenda Item : **AH04 + AH08**

Source : **Nortel Networks**

Title : **Downlink Compressed Mode by Puncturing, discussion on the description of the removal of p-bits**

Document for : **Decision**

---

1. Introduction

A solution for compressed mode by puncturing was proposed in RANWG1#10 meeting, and accepted in principle. It is characterised by the following :

- It is based on the insertion of bits marked p (a fourth value among 0,1 and δ already used) before the first interleaver at positions corresponding to radio frames that will be compressed. This enables to create naturally the desired gap for compressed mode in the desired radio frames when the bits p are removed later in the multiplexing chain.
- Room for these p-bits has been obtained by performing additional puncturing in the rate matching step. This puncturing has been performed on the whole TTI using the current rate matching algorithm, to use the good properties in terms of puncturing or repetition distance of this algorithm, and to prevent puncturing systematic bits of Turbo Codes.

The advantages of this method are:
- to provide a relatively simple method to obtain compressed mode by puncturing
- to modify the multiplexing chain as less as possible, both from an implementation and a description point of view
- to obtain good performance in terms of puncturing distance, and allow to respect the property of not puncturing the systematic bits of the Turbo Codes
- to avoid spoiling the properties of the combination of the first and second interleavers

At RAN1#10 meeting, an agreement was reached concerning the place to insert the p-bits in the multiplexing chain.
The exact place to describe their removal could not be decided. Nortel had originally made a proposal to remove them in the Physical Channel Mapping block. However it was felt that this would require modifications of the second interleaver implementation. Thus this proposal was decided to be not suitable. Then two other proposals were discussed. One is to remove the p-bits in the Physical Channel Segmentation block. The other one is to remove the p-bits just after the first interleaver and before radio frame segmentation. These two proposals lead to the same output flow on the radio interface. So they are equivalent from a functional point of view. Thus the description does not lead to any implementation constraint, and manufacturers are free to implement this features the way they prefer even if it is not exactly the one described in the specification. It was thus decided in RAN1#10 meeting, that the description to be selected should be the one leading to the smallest modifications of the Specification, while being of course clear.

This paper discusses the two descriptions on the table along those lines, and proposes a conclusion on this issue.

2. Overview of the blocks of the multiplexing chain to be modified in both cases

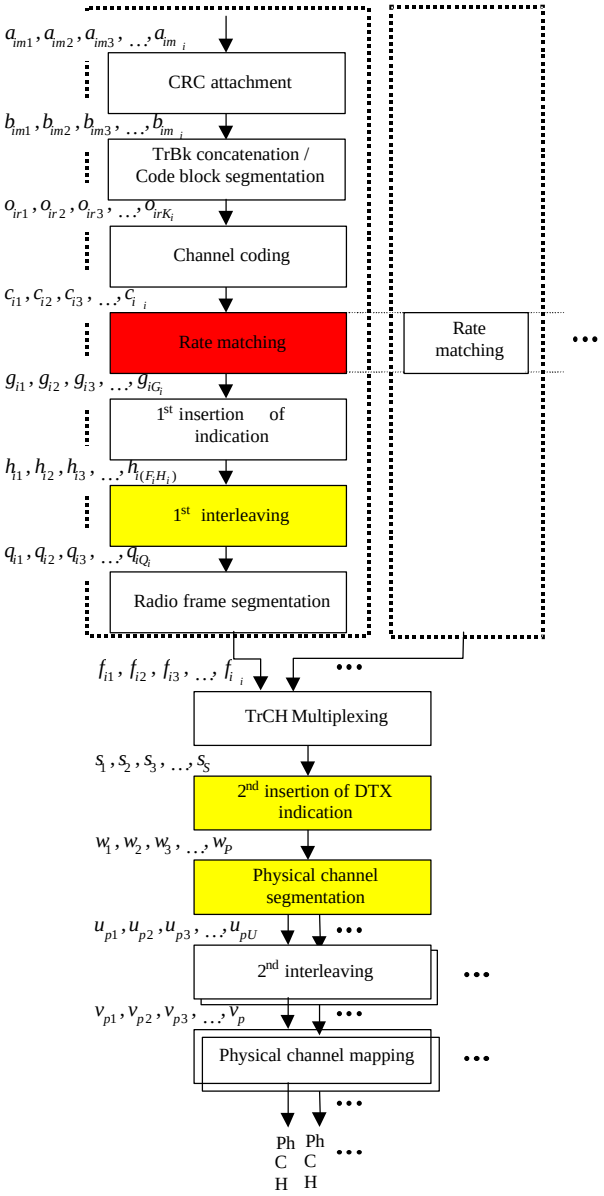

Fig-1 : Removal of p bit in the physical channel segmentation

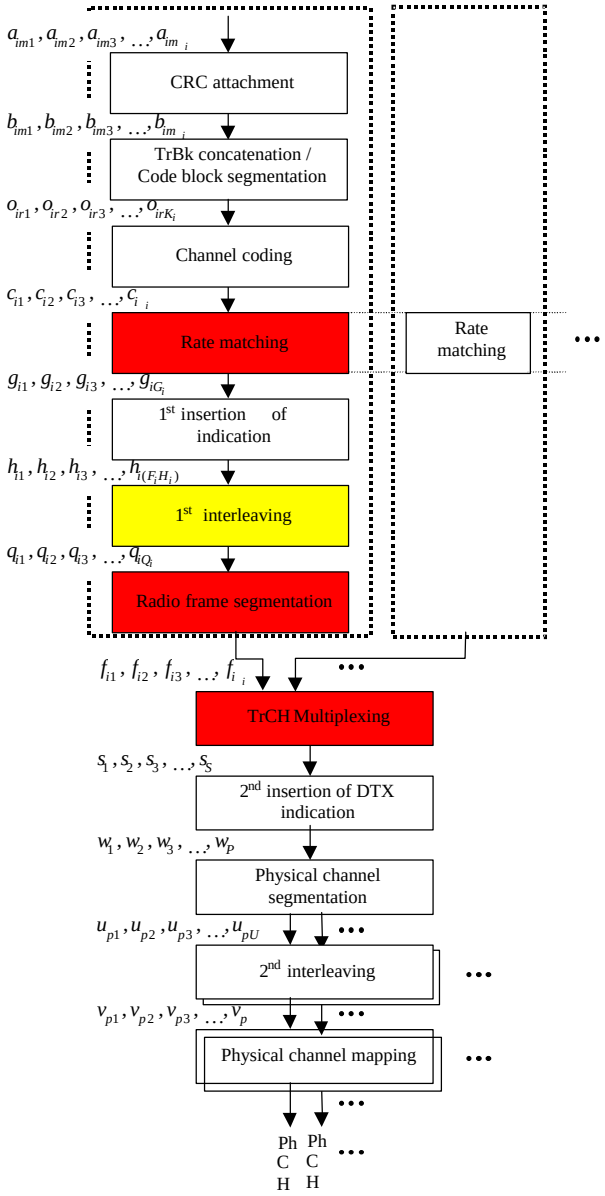

Fig-2 : Removal of p bit after the first interleaver

3. Removal of bits p described in Physical Channel Segmentation block

3.1 Concept of the proposal

One of the purpose of introducing the method based on p-bits insertion at one point of the chain and p-bits removal at the other end of the chain was to avoid modifying the blocks in between in the multiplexing chain. This was achieved by having an amount of bits additionally punctured in rate matching step corresponding exactly to the number of bits to be removed to create the gap. Additionallyhe positions corresponding to the desired gap were filled with p-bits at p-bits insertion step. Thus the total number of bits between insertion of bits p and the actual creation of the gap was the same as in normal mode, and no other block of the chain needed hence to be modified.

Thus it can be seen that the concept of this proposal is relatively straightforward. We need to remove some bits to create a gap for compressed mode. From a performance point of view, the best place to remove bits is in the rate matching step, together with the normal rate matching. But the actual place where we want to create the gap is in the last part of the chain. So in order not to have created the gap too early and suffer from the fact that then the number of bits of the TrCh is different from the number in normal mode in the whole chain, we introduce p-bits in the positions where the gap should be created. Then we remove the p bits only when we want actually to create the gap.

This was the reason for the original proposal of inserting the p-bits in the rate matching step, and removing them in the Physical Channel Mapping, where we thought the gap was actually created.

However, regarding the insertion of bits p, it appeared after some discussions that introducing the p-bits in the rate matching step was a bit complicated from a description point of view. So it was agreed to describe the insertion in the first interleaver step. Meanwhile, this induced modification of the 1st DTX insertion block. The reason for these modifications is that now, in this block between the additional puncturing block and the insertion of p-bits block, the total number of bits is not the same as in normal mode. These modifications lead to a slightly more difficult reading of the specification since they create another specific case in this 1st DTX insertion block.

Regarding the removal of p-bits, it was argued that performing this removal in the Physical Channel Mapping block would lead to modification of the implementation of the second interleaver compared to other compressed modes. Also after some more analysis of the construction of the specification, it was felt that the real first place where some space is reserved for the gap is in Physical Channel Segmentation block. So another proposal was made which enables to follow this line and to lead to a minimum modification of the chain. This proposal removes the p-bits in Physical Channel Segmentation block.

3.2 Identification of the two modifications needed in the Specification:

In the Physical Segmentation Block, the bits flow is mapped on each of the codes allocated to the CCTrCh. It is thus very easy to describe the p bits removal while doing this mapping, we just do not take into account the p-bits from the input flow, and we map only the bits not having value p. In this way this block is very similar to what it is for normal mode and other compressed mode. The only difference is that we “jump” over the bits with value p from the input flow. This can be expressed by using a function f.. This is the same kind of simple description as what is used in bit collection section to remove the bits which have been marked δ in the rate matching section, and that should actually be punctured so removed at this stage.

The previous description is the main modification needed to remove the p-bits in the chain.

Indeed, as can be seen from the introducing figure, one modification has also to be done in 2d DTX insertion step. This is due to the fact that the same variable U was used to indicate the limit for 2d DTX insertion of bits (P*U), and the number of bits to be mapped on each code (U). Thus it linked these two numbers. In other modes than compressed mode by puncturing, these numbers of bits are linked by P. However in compressed mode by puncturing, these two numbers are not linked. The reason is that since the p-bits already reserve the room for the gap, we can fill the whole frame with DTX bits (as in normal mode). We do not need to reserve space for the gap at this stage. It is only when the p-bits are removed that we obtain U bits on each code to create the gap. So we had to use different variables to address each of them. This is the reason for introducing variable R which can be either equal to U, or not in our case. Introducing this variable R and using it is the only modification in 2dDTX insertion.

As a summary, the only consequences of the description of the p-bits removal in Physical Channel Segmentation are the two following ones. One is a slight modification of the Physical Block Segmentation itself: we say that when bits are mapped to the codes, in compressed mode by puncturing, only bits with value different than p are mapped while in

other modes all bits are mapped. The second one is that we introduce a new variable to identify the limit for 2d insertion of DTX bits, since it is not linked to the number of bits per code as it is for other modes.

4. Removal of bits p described between First Interleaver and Radio Frame Segmentation blocks

If removal of p-bits was described just after first interleaver, the gap would actually be created very early in the chain. This is earlier than the place where the gap has actually to be created.

The following would have to be modified :

- First an algorithm to scan the bits output from First Interleaver has to be described, with the relation between the input and output bits of this feature which is a new functionality.
- Then radio frame segmentation can not be described as putting the same number of bits in each frame. Unequal radio frame segmentation has to be described. This is what had been tentatively described in Nokia's original proposal. However, it seemed relatively complicated to describe it in a simple way. New indexes had to be introduced since the number of bits to put in each frame is different.
- Then the Transport Channel Multiplexing block would have to be modified. The reason is that in different frames of their TTI, the TrCHs would not have the same number of bits. So here again, new indexes should be introduced. Also a way to clarify the exact number of bits in each radio frame for each TrCh has to be found. The size of the blocks of each TrCh would have to be re-calculated frame by frame according to the Transport Format Combination and the gap in each frame.

As a summary, it can be seen that one functional block would have to be introduced to describe the scanning of the bits flow at the output of first interleaver to remove the p-bits. Also Radio Frame Segmentation block would be modified to describe unequal segmentation. Moreover Transport Channels Multiplexing block would have to be modified to describe the different size of the blocks to be multiplexed from one frame to the next inside the TTI, according to the TFC and the gap of each frame.

5. Conclusion

The modifications of the multiplexing chain necessary in case of each of the descriptions for p-bits removal have been listed in this document. It appears that the proposal to remove the bits p in the Physical Segmentation block leads to significantly fewer modifications than the proposal to remove the bits p after the First Interleaver, and has a clear conceptual reason. Since the recommendation from RANWG1#10 was to take the description providing the less modifications, it is felt that removal of p-bits should be described in Physical Channel Segmentation.

CR 25.212-042r4 in Tdoc R1-00-0358 has been drafted along this line.