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Source : Nortel Networks

Title : Proposal for inclusion of text on Impact of Hybrid type II/III ARQ on the physical layer in the Technical report 25.835

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1 Introduction

Work on the introduction of Hybrid Type II/III ARQ is currently progressing in RAN 2, which has the lead responsibility on this work item. The main features of Hybrid type II/III ARQ were discussed and possible impact on Layer 2 and layer 3 identified considering two main proposals for the transfer of user data and side information to support the RLC operation. Outcome of the discussion in RAN 2 and over the RAN 2 reflector is captured into a technical report drafted by the editor and contained into [1], submitted for RAN2#15. Detailed impact of Hybrid Type and in particular hybrid type II/III ARQ on the physical layer have currently not been addressed in the technical report.

This document proposes some text for inclusion in the TR in relation of the impact of HARQ II/III on the physical layer mechanisms on the basis of contributions discussed in RAN 1 [1][2].

2 References

[1] : R1-00-1090, Impact of Hybrid type II/III ion the physical layer, Nortel Networks

(2] : R1-00-0962, Multiplexing Chain for HARQ , Siemens

3 Proposed text for inclusion in TR 25.835

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7 Physical Layer impacts

7.1 Overview of physical layer mechanisms

In this section requirement set by HARQ in the RLC onto the physical layer are clarified. Then impact on to the multiplexing and channel coding are derived for the FDD downlink on one side and FDD uplink, TDD uplink and downlink on another side.

7.1.1 General requirements from RLC assumed for impact evaluation

Different Hybrid type ARQ schemes are identified in section 5.1 of this report. For Hybrid ARQ type II and Hybrid type III, two cases can be considered : either there is one redundancy version (in which case it is identical to the ARQ type I on the transmitter side, combining of retransmission of the same information taking place in the receiver) or there are several redundancy versions. In this section multiple redundancy version are assumed, as this corresponds to the broader scope

Considering that redundancy version characterises the channel coding and rate matching pattern (repetition or puncturing) applied onto an RLC PDU, It is therefore understood that the introduction of HARQ II/III requires to have some control of the RLC onto the channel coding

including rate matching that is applied on a RLC PDU, which in turn means that the exact rate matching pattern applied performed onto a transport block can be controlled by the RLC assuming that one RLC maps into one transport block.

It is to be clarified whether multiple redundancy versions between which combination of soft bits can occur correspond to the same overall code rate or compatible code rates or may have not relation between each other.

7.1.2 Impact on downlink FDD for user data transmission

Impact of HARQ on transmission of user data on the channel coding and multiplexing scheme is analysed in the following. An example of the modification of the channel coding and multiplexing processing chain is provided in Figx1 below and further explanation provided hereafter;

- Code block concatenation removal

The rate matching is performed on the TTI basis after code block segmentation and concatenation and is transport format specific (transport block size, number of transport block) (for the flexible position case). In order to provide some visibility on rate matching on the transport block level , then code block concatenation is to be disabled for transport channels that apply HARQ. Currently code block concatenation is performed on all transport block of the transport block set of one TTI and then code block segmentation applied if the resulting code block size after concatenation is above a certain limit 504 respectively 5114 bits for convolutional respectively turbo codes). If we were to disable the code block concatenation then this should be done under the control of higher layers and hence this should be a static parameter of the transport channel.

- Redundancy version handling and impact on MAC

Considering that the redundancy version characterises the rate matching pattern then it means that it is transport format specific. If additionally all redundancy version are to correspond to the same overall code rate, then it means that initial transmission and retransmission are to correspond to the same Transport format, which sets requirements onto the MAC scheduling this means a constant bit rate for the transport channel on which HARQ is applied, If rate compatible codes are considered then retransmission may occur only with Transport format compatible.

- Rate matching algorithm enhancement

Currently the puncturing/repetition pattern is solely parametrised by the number of bits to puncture or repeat, meaning that for a given transport block size, the pattern is identical if the number of bits or add /remove is the same. In order to obtain multiple redundancy version, the rate matching pattern determination need to be enhanced. Compatible patterns should be optimised as function of the maximum number of redundancy versions assumed by the protocol.

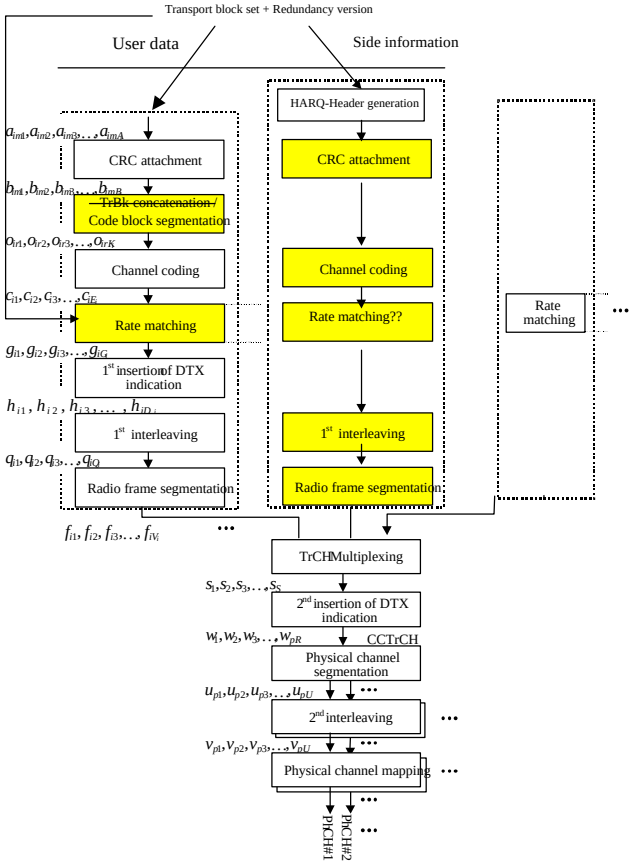

Fig1x : Impact of HARQ on channel coding and multiplexing processing chain for FDD downlink

7.1.3 Impact in the uplink FDD and uplink and downlink TDD of user data transmission

Impact of HARQ on transmission of user data on the channel coding and multiplexing scheme was evaluated. The evaluation is based on an example of the modification of the channel coding and multiplexing processing chain as illustrated in Figx2 below ;

On the uplink FDD and in TDD the rate matching is performed at the radio frame level therefore after radio frame segmentation, that is the say segmentation of transport block onto the different radio frames contained in one TTI (considering TTI s larger than 10 ms) and is transport format combination specific. Therefore the rate matching pattern on a transport block is the result of the rate matching pattern on the transport channel on all radio frames within one TTI. How to accommodate the notion of redundancy version is not clear and leads to the following questions :

- Would a redundancy version correspond to a set of patterns possibly different on the different radio frames of a TTI or should the patterns be the same, meaning among other things that they should correspond to the same amount of puncturing/repetition for all radio frames of the TTI ?
- Considering that the rate matching is TFC specific does it means that all radio frames in the TTI of the transport channel on which HARQ is performed should correspond to the same TFC ? This set limits not only onto the transport formats for the initial transmission and

retransmission as in the downlink case, but also on transport format of other transport channel simultaneously transmitted.

- If the redundancy versions correspond to the same overall code rate , than all TFC contained in the radio frames of the TTI for initial and retransmission should be the same ?

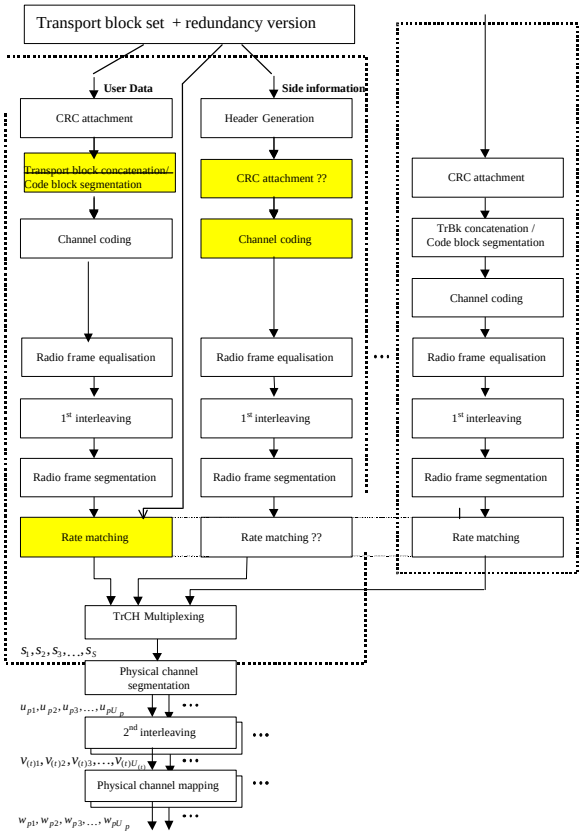

Fig2x : Impact of HARQ on FDD uplink and TDD

7.1.4 Impact of Transmission of side information

Two main approaches are captured in this technical report for the transfer of side information, where side information corresponds to the RLC PDU sequence number and the redundancy version. These are case A and B described in sections 6.2 and 6.3.

Impact of case A

For case A, in the two first sub-cases as identified in 6.2.1the side information is carried over the same transport channel as the user data. However the side information needs better protection and needs to be encoded separately so that the redundancy version and sequence number can be separately decoded before soft bit combinations for user data. Impact is several fold

1. This means that unequal error protection is to be added to allow different protection scheme for the same transport channel.
2. Side information would typically correspond to short block. Block code are typically more appropriate than convolutional code or Turbo codes for short blocks, so code block may need to be introduced. Some indication as to what would the side information size should be provided.
3. It is to be checked whether rate matching can apply onto this sub-flow of a transport channel bits (is puncturing allowed for example ?).

Impact of case B

In the case B the side information is carried over a separate transport channel so unequal protection is not needed. However items 2 and 3 for case A are valid as far as the use of short block and the rate matching is concerned.