3GPP TSG-RAN WG1#8
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Agenda Item: Adhoc 4

Source: Nokia

Title: Proposal how to send AMR mode commands in downlink

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1. Introduction

In last WG1 meeting there was already some discussion how to define the AMR transmission for different Classes of bits. In TS 26.101, "AMR speech codec frame structure", there is however some AMR auxiliary information defined for Generic AMR frame, which was not yet part of that discussion. One of these auxiliary informations is Mode Indication, 3 bits. This contribution discusses how these Mode Indication bits could be transmitted through Air Interface.

2. Purpose of Mode Command bits

With the Mode Command bits the RNC can command the UE to change the mode in uplink.

To avoid misunderstandings, the mode changes in downlink are not achieved with Mode command bits, but instead with TFCI or BRD.

Within WCDMA, the main purpose of changing the AMR mode is slow adaptation to the capacity limited situation in downlink, or capacity or coverage limited situation in uplink. The adaptation by changing the mode, will be very slow, since outer loop and inner loop power control will take care of the fast adaptation in WCDMA.

The main question is how to send the mode commands from RNC to UE. Due to the slow adaptation rate in WCDMA, there has been some ideas that L3 signaling could be used.

The possible case where the mode commands should be sent very fast from RNC to UE is , when we have TFO (tandem free operation) connection between UMTS and GSM, so called UE - MS connection. Since in GSM the mode adaptation can be very dynamic, sending the mode commands fast from RNC to UE has to be possible then also in WCDMA. There has been some comments that in that case, one additional transport channel is needed for sending these mode commands in downlink.

We are aware that WG2 discussed this issue in their last meeting, and there the opinion was that there should be a separate transport channel reserved for transmitting mode commands.

3. L1 design for support of transmitting Mode command bits

It should be understood that if we reserve a separate transport channel for transmitting mode commands, the present L1 transport channel multiplexing scheme is not applicable. The reason is that we cannot use convolutional coding for encoding only 3 Mode command bits.

In WG2 discussions, it was proposed that a new, special block coding method is defined for this purpose. This does not sound very attractive idea, and is quite questionable , whether this will offer very good performance either. This is the lesson that was learned when the coding methods for TFCI bits were studied. For TFCI, it was absolutely necessary to define a special coding method, because otherwise we can not have the variable rate transmission where data rate can change every 10 ms. But if we do have other choices for transmitting the mode command bits, than with specialised block coding, then all those alternatives should be considered, because good performance, and optimising the radio capacity should be one of the main issues when designing this.

For this reason, we propose that Mode Command bits can be encoded together with the speech bits. This will mean that we need to introduce again the 1st multiplexing block to Layer 1. It used to be there but was deleted some time ago.

Figure 1 shows the multiplexing chain , if we introduce the 1st multiplexing back to the transport channel multiplexing diagram. Figure 2 and 3 show what kind of coding and multiplexing configurations are then possible for transmitting mode command bits along with AMR.

=> CRC attachment => TrBK concatenation=>**1st multiplexing**=>Code block segmentation=>channel coding => etc.

Figure 1. Transport channel multiplexing. Proposed new block: 1st multiplexing.

| Class A | CRC | ModeC | Class B | Class C |
<--------------TrCH1-------------------------><TrCH2 ><--TrCH3-------><TrCH3 >
<---------------------Coding1-----------------------------><--Coding2-----><Coding3>

Figure 2. Four transport channels and three "coding and multiplexing legs" in CCTrCH.

| Class A | CRC | Class B | ModeC | Class C |
<---------------------TrCH1 ------------------><------TrCH2--- >< TrCH3><TrCH4 >
<---------------------Coding1-----------------><-----------Coding2----------><Coding3>

Figure 3. Three transport channels three "coding and multiplexing legs" in CCTrCH.

The case in figure 2 should be used if Mode commands are not present in every frame and BRD is used for transport format detection. Probably the case in figure 2 is more sensible anyway.

4. Why 1st multiplexing was deleted before

So, our main proposal is that we propose that Mode Command bits can be encoded together with the speech coding bits. This will mean that we need to introduce again the 1st multiplexing to Layer 1. It used to be there but was deleted from there, with following argumentation:

- MAC multiplexing can be used instead. This is not true for AMR, because with transparent mode there are no MAC headers , and in that case MAC multiplexing is not possible.
- In the old definition, 1st multiplexing was defined in that way that only transport blocks of the same size were allowed to be multiplexed in the 1st multiplexing. The historical reason for this was, that it was thought that all the transport blocks will always require the same FER (frame error rate), otherwise this block is not needed, or cannot be used. However here, now, we have the case where we would benefit from this 1st multiplexing, even if we do have different Transport block sizes.

5. Should we have Mode command bits in each TTI

Mode command bits do not have to be transmitted in each TTI. The transport channel containing the mode command bits can have two transport formats: on/off. For the transport format detection, this will mean that the number of transport format combinations during the connection is doubled. For BRD this will mean also that mode command bits has to be encoded together with Class A bits, because the CRC is attached to Class A bits.

Anyway, it is possible, both with TFCI and with BRD, to have a scheme where Mode commands are not present in every TTI, if desired.

6. Conclusion and proposal

We propose that we introduce the 1st multiplexing block back to the Layer 1 transport channel multiplexing structure. With this, we have the possibility to encode mode command bits together with speech bits, and we can avoid the need to have a special block coding scheme for this purpose. See the text proposal below.

7. Text proposal to S25.212

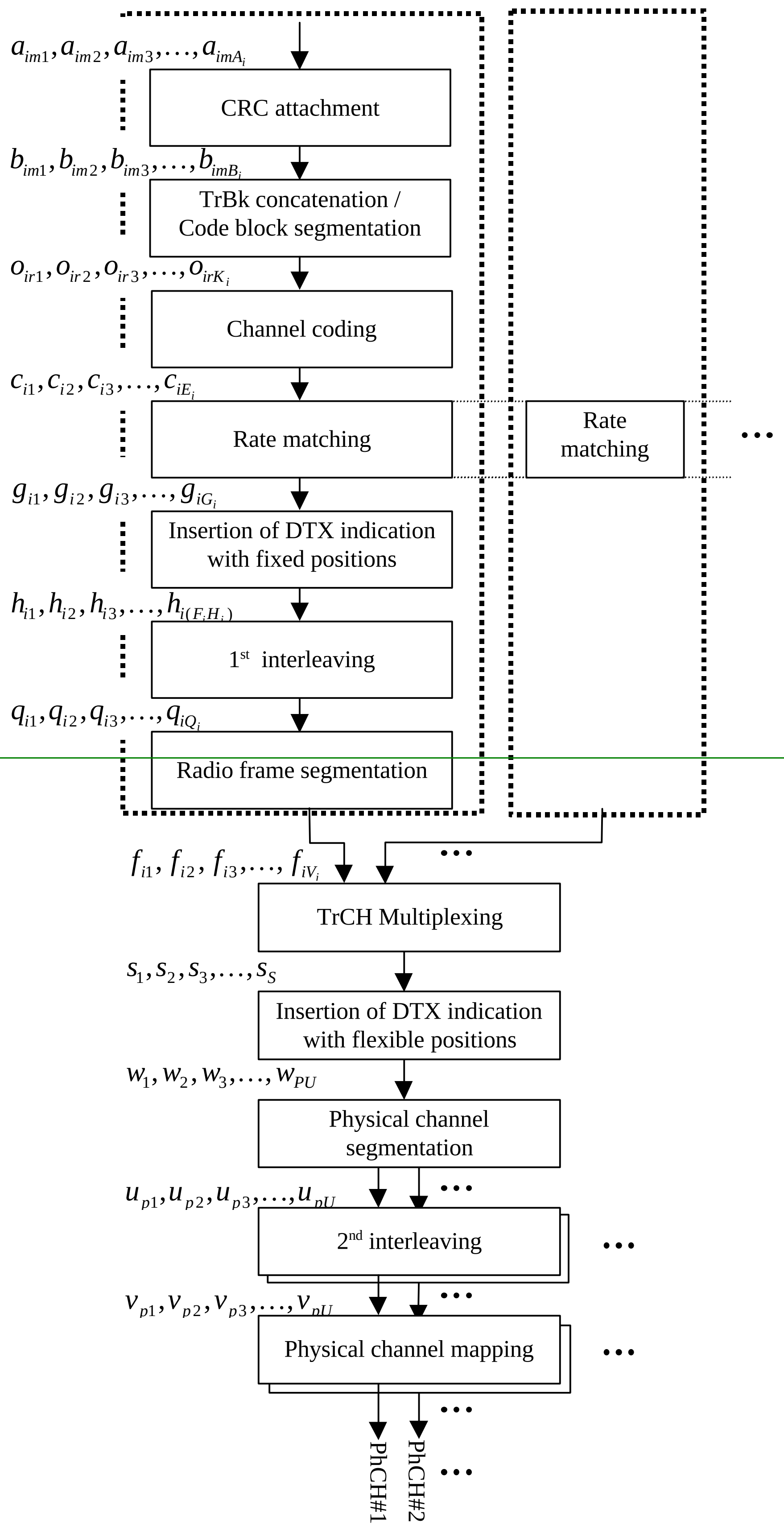
4.2 Transport-channel coding/multiplexing

Data arrives to the coding/multiplexing unit in form of transport block sets once every transmission time interval. The transmission time interval is transport-channel specific from the set {10 ms, 20 ms, 40 ms, 80 ms}.

The following coding/multiplexing steps can be identified:

- Add CRC to each transport block (see Section **Error! Reference source not found.**)
- Transport block concatenation (see Section 4.2.2)~~and code block segmentation (see Section 0)~~
- 1st multiplexing (see section 4.2.3)
- code block segmentation (see Section 4.2.4)
- Channel coding (see Section **Error! Reference source not found.**)
- Rate matching (see Section **Error! Reference source not found.**)
- Insertion of discontinuous transmission (DTX) indication bits (see Section **Error! Reference source not found.**)
- Interleaving (two steps, see Section **Error! Reference source not found.** and **Error! Reference source not found.**)
- Radio frame segmentation (see Section **Error! Reference source not found.**)
- Multiplexing of transport channels (see Section **Error! Reference source not found.**)
- Physical channel segmentation (see Section **Error! Reference source not found.**)
- Mapping to physical channels (see Section **Error! Reference source not found.**)

The coding/multiplexing steps for uplink and downlink are shown in **Error! Reference source not found.** and respectively.



~~**Figure 1: Transport channel multiplexing structure for downlink**~~

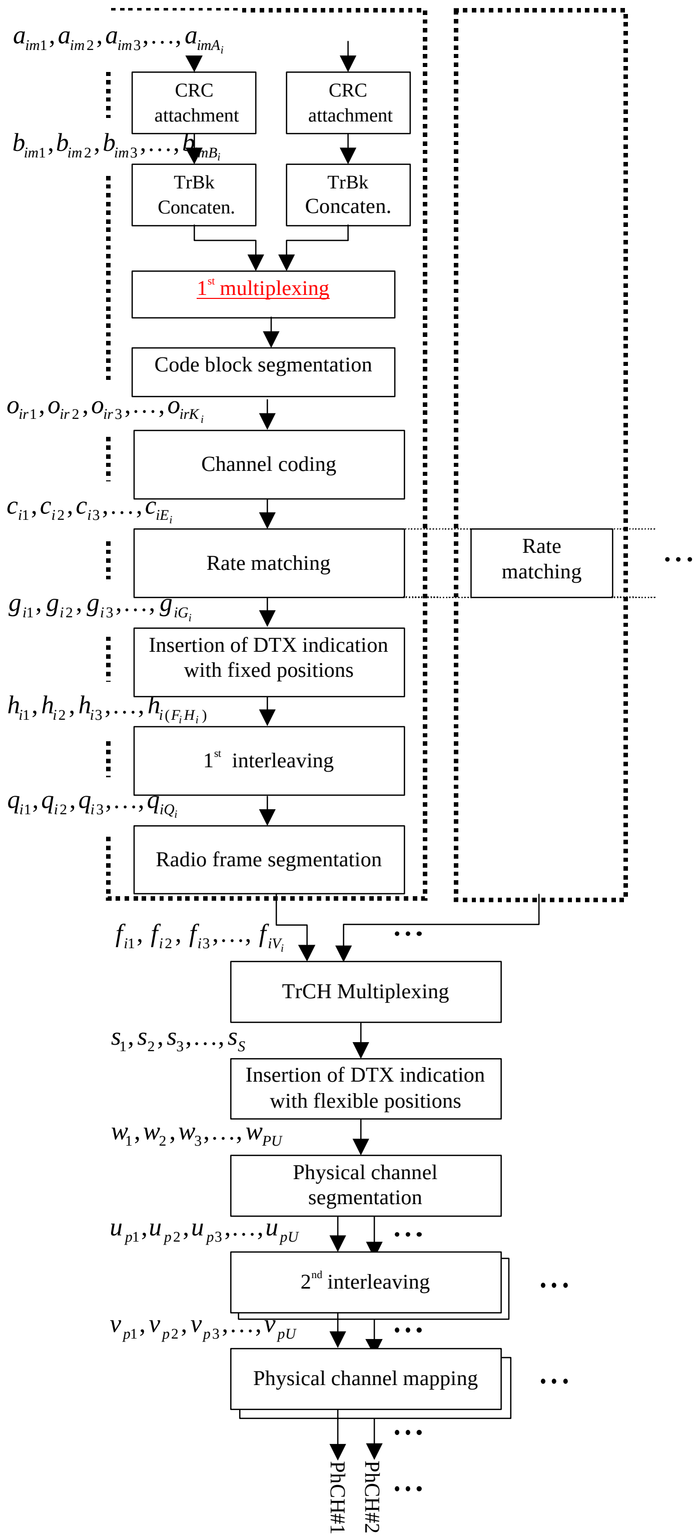


Figure 2: Transport channel multiplexing structure for downlink

4.2.2 Transport block concatenation ~~and code block segmentation~~

All transport blocks in a TTI are serially concatenated. ~~If the number of bits in a TTI is larger than Z, then code block segmentation is performed after the concatenation of the transport blocks. The maximum size of the code blocks depend on if convolutional or turbo coding is used for the TrCH.~~

~~4.2.2.1 Concatenation of transport blocks~~

The bits input to the transport block concatenation are denoted by $b_{im1}, b_{im2}, b_{im3}, \ldots, b_{imB_i}$ where i is the TrCH number, m is the transport block number, and B_i is the number of bits in each block (including CRC). The number of transport blocks on TrCH i is denoted by M_i. The bits after concatenation are denoted by $x_{i1}, x_{i2}, x_{i3}, \ldots, x_{iX_i}$, where i is the TrCH number and X_i=M_iB_i. They are defined by the following relations:

$x_{ik} = b_{i1k}$ $\quad k = 1, 2, \ldots, B_i$

$x_{ik} = b_{i,2,(k-B_i)}$ $\quad k = B_i + 1, B_i + 2, \ldots, 2B_i$

$x_{ik} = b_{i,3,(k-2B_i)}$ $\quad k = 2B_i + 1, 2B_i + 2, \ldots, 3B_i$

…

$x_{ik} = b_{i,M_i,(k-(M_i-1)B_i)}$ $\quad k = (M_i - 1)B_i + 1, (M_i - 1)B_i + 2, \ldots, M_iB_i$

4.2.3 1st multiplexing

The bits from different transport channels are multiplexed into the same bit stream to allow encoding them together.

The bits output from the 1st multiplexing are denoted by $d_{j1}, d_{j2}, d_{j3}, \ldots, d_{jD_j}$ where j is the number of the coding and multiplexing leg in the TrCH multiplexing block (see section 4.2.8 Transport channel multiplexing) and $D_j = X_i + X_{i+1} + X_{i+2} + \ldots + X_{i+N-1}$. N is the number of transport channels multiplexed to the same bit stream in 1st multiplexing. Here $X_i=M_iB_i$, where Mi is the number of transport blocks on TrCHi and Bi is the number of bits in each block, including CRC. Note that the number of bits from each transport channel does not have to be equal. x_{ik} is defined in the previous section, 4.2.2.

The relations between input bits and output bits in this block are defined as below:

$d_{jk} = x_{ik}$ $\quad k = 1, 2, \ldots, X_i$

$d_{j(k+X_i)} = x_{(i+1)k}$ $\quad k = 1, 2, \ldots, X_{i+1}$

$d_{j(k+X_i+X_{i+1})} = x_{(i+2)k}$ $\quad k = 1, 2, \ldots, X_{i+2}$

…

$d_{j(k+X_i+X_{i+1}+\ldots+X_{i+N-1})} = x_{(i+N-1)k}$ $\quad k = 1, 2, \ldots, X_{i+N-1}$

~~4.2.2.2~~ 4.2.4 Code block segmentation

Segmentation of the bit sequence from transport block concatenation is performed if ~~X_i~~ D_j >Z. The code blocks after segmentation are of the same size. The number of code blocks ~~on TrCH i~~ on the coding and multiplexing leg in the TrCH multiplexing block (see section 4.2.8 Transport channel multiplexing) is denoted by C_j ~~C_i~~. If the number of bits input to the segmentation, ~~X_i~~ D_j, is not a multiple of C_j ~~C_i~~, filler bits are added to the last block. The filler bits are transmitted and they are always set to 0. The maximum code block sizes are:

convolutional coding: Z = 512 - K_{tail}
turbo coding: Z = 5120 - K_{tail}

The bits output from code block segmentation are denoted by ~~$o_{ir1}, o_{ir2}, o_{ir3}, \ldots, o_{irK_i}$~~ $o_{jr1}, o_{jr2}, o_{jr3}, \ldots, o_{jrK_j}$, where j is the number of the coding and multiplexing leg in the TrCH multiplexing block (see section 4.2.8 Transport channel multiplexing) ~~i is~~

~~the TrCH number~~, r is the code block number, and K_j ~~K_i~~ is the number of bits.

Number of code blocks: $C_j = \lceil D_j / Z \rceil$ ~~$C_i = \lceil X_i / Z \rceil$~~
Number of bits in each code block: $K_j = \lceil D_j / C_j \rceil$ ~~$K_i = \lceil X_i / C_i \rceil$~~
Number of filler bits: $Y_j = C_j K_j - D_j$ ~~$Y_i = C_i K_i - X_i$~~

If D_j ~~X_i~~ $\le Z$, then $o_{j1k} = d_{jk}$ ~~$o_{i1k} = x_{ik}$~~, and $K_j = D_j$ ~~$K_i = X_i$~~.
If D_j ~~X_i~~ $\ge Z$, then

~~$o_{i1k} = x_{ik}$ $k = 1, 2, \ldots, K_i$~~

~~$o_{i2k} = x_{i,(k+K_i)}$ $k = 1, 2, \ldots, K_i$~~

~~$o_{i3k} = x_{i,(k+2K_i)}$ $k = 1, 2, \ldots, K_i$~~

~~$\ldots$~~

~~$o_{iC_ik} = x_{i(k+(C_i-1)K_i)}$ $k = 1, 2, \ldots, K_i - Y_i$~~

~~$o_{iC_ik} = 0$ $k = (K_i - Y_i) + 1, (K_i - Y_i) + 2, \ldots, K_i$~~

$o_{j1k} = d_{jk}$ $k = 1, 2, \ldots, K_j$

$o_{j2k} = d_{j,(k+K_j)}$ $k = 1, 2, \ldots, K_j$

$o_{j3k} = d_{j,(k+2K_j)}$ $k = 1, 2, \ldots, K_j$

$\ldots$

$o_{jC_jk} = d_{j(k+(C_j-1)K_j)}$ $k = 1, 2, \ldots, K_j - Y_j$

$o_{jC_jk} = 0$ $k = (K_j - Y_j) + 1, (K_j - Y_j) + 2, \ldots, K_j$

4.2.4 Channel coding

The chapters after this needs following updates:

- replace i (transport channel number) by j (number of the coding and multiplexing leg in the transport channel multiplexing)
- replace the term "transport channel multiplexing" by "coding multiplexing leg in the transport channel multiplexing", when needed, or invent a better term for that.