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Agenda Item : AH23 (R'00 measurement refinement work item)

Source : Mitsubishi Electric (Trium-RD)

Title : UL multiframe Compressed mode (release 2000)

Document for : Discussion and Decision

Introduction

In this paper we present a methods allowing to implement multiframe compresssed mode in the UL. Multiframe compressed mode, or compressed mode method A2 means that the compression is carried out over several radio frames, even if not all of them overlap a transmission gap. This is to be opposed to method A1 and B that affect only the radio frames overlapping with a transmission gap.

References

[1] 25.212 ver 3.2.0, Multiplexing and channel coding (FDD), source RAN

[2] Tdoc R1-00-461, Downlink Compressed Mode by Puncturing, revision 2, souce Mitsubishi

Abbreviations

CM	Compressed Mode
RM	Rate Matching
TF	Transport Format
TFC	Transport Format Combination
TrCH	Transport Channel
UL	Uplink

Multiframe UL CM

Notations

We recall the following notation (most of them already defined in 25.212 [1]).

$E_{i,l}$	block size for TrCH i and TF *l* after channel coding
$T_{i,l}$	block size for TrCH i and TF *l* after radio frame equalisation
$T_{i,l}^{cm}$	block size for TrCH i and TF *l* after radio frame equalisation in multi frame compressed
F_i	TTI duration of TrCH *i* as a radio frame number
F_{max}	Longest TTI duration in the CCTrCH
$FS_{i,l}^{cm,n}$	Radio frame segment for TrCH *i*, TF *l*
$N_{i,j}$	block size for TrCH i and TFC *j* after radio frame segmentation
$V_{i,j}$	block size for TrCH i and TFC *j* after radio rate matching in normal mode
$V_{i,j}^{cm}$	block size for TrCH i and TFC *j* after radio rate matching in single frame compressed mode (B or A1)
$V_{i,j}^{cm,n}$	block size for TrCH i and TFC *j* after radio rate matching in multi-frame compressed mode (A2) for radio frame with number n within longest TTI, $0 \le n < F_{max}$
$SC_{F,n}$	Segmentation Coefficient for TTI duration F in {1,2,…,*Fmax*} and for radio frame number *n* within longest TTI, $0 \le n < F_{max}$
$N_{data,j}$	Number bits of avaible to the CCTrCH in normal mode
$N_{data,j}^{cm}$	Number bits of avaible to the CCTrCH in compressed mode, in the single frame compressed mode (B or A1)
$N_{data,j}^{cm,n}$	Number bits of avaible to the CCTrCH in compressed mode for frame number n within the longest TTI ($0 \le n < F_{max}$), in the multiframe frame compressed mode (A2)
$TF_i(j)$	TF of TrCH *i* corresponding to TFC *j*
I	number to TrCH in the CCTrCH
RM_i	Rate Matching Attribute of TrCH *i*
$N_{Tr,n}$	Number of transmitted slots in frame with number n within the longest TTI ($0 \le n < F_{max}$).

Current Rate Matching in normal and compressed mode

Normal mode case

In normal mode the block size after RM is computed as follows :

$$V_{i,j} = Z_{i,j} - Z_{i-1,j}, \quad (1)$$

where

$Z_{0,j} = 0$, and

$$Z_{i,j} = \left\lfloor \frac{\sum_{m=1}^{m=i} RM_m \cdot N_{m,j}}{\sum_{m=1}^{m=I} RM_m \cdot N_{m,j}} \cdot N_{data,j} \right\rfloor . \quad (2)$$

The radio frame equalisation is done by adding filler bits so that $T_{i,l}$ be a multiple of F_i : $T_{i,l} = F_i \cdot \left\lceil \frac{E_{i,l}}{F_i} \right\rceil$

And thus radio frame segmentation can be done by simple equal segmentation : $N_{i,j} = \frac{T_{i,TF_i(j)}}{F_i}$.

Single frame compressed mode case

The compressed mode with single frame is very similar to thenormal mode, as the only thing to do is to replace $N_{data,j}$ by $N^{cm}_{data,j}$ in the Z formula (2).

So we have :

$$V^{cm}_{i,j} = Z_{i,j} - Z_{i-1,j} , \quad (1bis)$$

where

$Z_{0,j} = 0$, and

$$Z_{i,j} = \left\lfloor \frac{\sum_{m=1}^{m=i} RM_m \cdot N_{m,j}}{\sum_{m=1}^{m=I} RM_m \cdot N_{m,j}} \cdot N^{cm}_{data,j} \right\rfloor . \quad (2bis)$$

Multi frame compressed mode case

Now we will see the multi-frame compressed mode block sizes can be computed with small additional complexity compared to the other case.

Block size computation

Radio frame segmentation is no longer equal in order to put less bits in the radio frames with transmission gaps.

So first of all the radio frame equalisation function is removed :

$$T^{cm}_{i,l} = E_{i,l}$$

Then, the radio frame segmentation is done along segmentation coefficients $SC_{F,n}$ and we have :

$$FS_{i,l}^{cm,m\cdot F_i+n} = \left\lfloor \left(\sum_{x=0}^{x=n} SC_{F_i,m\cdot F_i+x} \right) \cdot E_{i,l} \right\rfloor - \left\lfloor \left(\sum_{x=0}^{x=n-1} SC_{F_i,m\cdot F_i+x} \right) \cdot E_{i,l} \right\rfloor \quad (3)$$

Where by convention $\sum_{x=0}^{x=-1} . = 0$, and *m* is the TTI number within the longest TTI ($0 \le m < \frac{F_{\max}}{F_i}$),and *n* is the radio frame number within the TTI ($0 \le n < F_i$.).

The radio frame segmentation is such that the first $FS_{i,l}^{cm,F_i\cdot m}$

The formula (3) is very similar of what is done in the combination of formula (1) and formula (2).

Then, the block size after RM is simply computed by replacing $N_{i,j}$ by $FS_{i,TF_i(j)}^{cm,n}$ and $N_{data,j}$ by $N_{data,j}^{cm,n}$ in formula (2). So we have :

$$V_{i,j}^{cm,n} = Z_{i,j} - Z_{i-1,j} , \quad (1ter)$$

where

$Z_{0,j} = 0$, and

$$Z_{i,j} = \left\lfloor \frac{\sum_{m=1}^{m=i} RM_m \cdot FS_{m,TF_m(j)}^{cm,n}}{\sum_{m=1}^{m=I} RM_m \cdot FS_{m,TF_m(j)}^{cm,n}} \cdot N_{data,j}^{cm,n} \right\rfloor . \quad (2ter)$$

1st Interleaver

The first interleaver is changed in a similar way as the one for the CM by puncturing in DL (see the description of [2], and in [1] the p-bits are removed later that immediately after 1st IL) . That is to say :

- The number of row *RI* is taken to the max of the segment size $RI = \max_{0 \le n < F_i} \left\{ FS_{i,l}^{cm,m\cdot F_i+n} \right\}$.
- The number of column is taken to F_i *: CI =* F_i
- The beginning of each column number $P_i(n)$ is filled by $RI - FS_{i,l}^{cm,m\cdot F_i+n}$ p-bits
- The matrix is filled row-wise with the data bits, excluding the positions where there are already p-bits
- The interleaving is performed
- The p-bits are removed from the interleaved data.

Determination of Segmentation Coefficient

The segmentation coefficients can be determined by a similar method as in [2] :

$$SC_{F,m\cdot F+n} = \frac{N_{Tr,m\cdot F+n}}{\sum_{x=0}^{x=F_i-1} N_{Tr,m\cdot F+x}}$$

Like in [2] an alternative formula with some rounding can be used.

More elaborate methods are also possible.

Conclusion

In this paper we have presented a method to perform multiframe compressed mode in the UL.

The main chracterisistic of the methods are :

- Only changes in the coding chain are :
  - 1st IL changed in the similar way as for DL compressed mode by puncturing
  - unequal segmentation
  - other operation are performed in the same way, only parameters change.
- More block sizes to compute, but the complexity of computation / radio frame is comparable to what we have now.

We propose this method for release 2000.