

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

Agenda Item : AH04 + AH08
Source : Mitsubishi Electric (MCRD)
Title : Downlink Compressed Mode by Puncturing
Document for : Discussion and Decision

Introduction

Compressed mode by puncturing has been intensively discussed in RAN WG1 #10. In this paper we :

- highlight some problems existing in the current proposal [1]
- propose another solution based on segmentation coefficients.

References

[1] TSGR1#11(00)272 Downlink Compressed Mode by Puncturing, update, source Nortel Networks

Problems on the current proposition [1]

Problems in the determination of the amounts $\Delta N_{cm,i,l}^{TTI}$ in flexible positions

In the proposition [1] this amount is computed by means of the 'Z formula'. The object of this formula is to share in a weighed way an integer amount between several TrCH. In the case of compressed mode the amount shared is the amount of gap bits in the frame affected by compressed mode.

The problem with the current proposal [1] is that this sharing assumes some Transport Format Combination j . However [1] does not tell how to determine j . So our conclusion is that [1] is at best incomplete.

In fixed positions, there is no such problem, as one only needs to take a 'TFC' (be it virtual) where all the TrCH are simultaneously at highest bitrate.

Problems in the concept of sharing the gap.

In the current proposal [1], the gap is share by only the TrCH whose TTI are overlapping with the gap. We think that this is a bit restrictive as shown by the Figure 1 below. On this figure we consider 2 TrCHes, the white one and the grey one, the white TrCH has a TTI of 10ms while the grey TrCH has a TTI of 20ms. We assume that the 2 TrCh are constant rate TrCH. The surface of the squares represent the amount of data after rate matching.

As shown on this figure, not only (1.) and (3.) are compressed, but also (2.). The compression in the (frame 1) shorter TTI that does not overlap the gap is done by the intermediate of a TrCH whose (frames 0 & 1) longer TTI overlaps both the (frame 0) gap and the (frame 1) shorter TTI.

What is happening is like a kind 'communicating vase' thing :The gap is pressing on 1 and 3, 3 is in contact with 2, so 2 is also compressed. That is to say the grey TrCH giving bits to the gap, can also take bits from the 2nd TTI of the shorter TTI of the white TrCH.

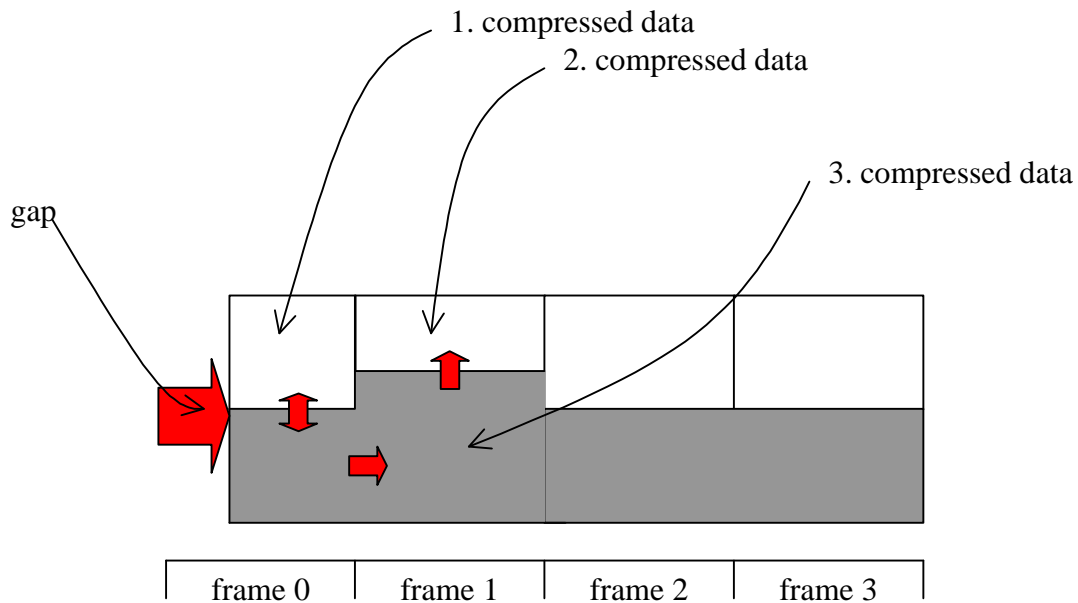


Figure 1 Example of compressed mode with several TTI durations

Of course, such kind of thing is relying on this that there is enough bit rate on the longer TTI TrCH compared to the shorter TTI TrCH. We believe that quite often this condition is fulfilled: for instance for the speech service we can have 40ms DCCH, and 20 ms DTCHes. The TrCH bit rate on the DCCH is roughly one third ($\approx 4\text{kbps}$) of that of the DTCHes ($\approx 12\text{kbps}$), but when seen after the channel coding this proportion is most likely higher because the BER requirement of the DCCH is lower than that of the DTCHes. Moreover, we will have also the rate command that can be of 40ms TTI.

Note that our approach allows to keep the TrCH balanced, compared to [1] where for Figure 1 example the power will need power increase in frame 1 as required by the longer TTI TrCH, and so the shorter TTI TrCH will have too good quality.

Other minor problems

The current [1] does not seem to take into account the benefit of jointly using higher layer scheduling and CM by puncturing, whereas in our proposal we take it into account.

However, we believe that this problem can be easily solved, so this is not a fundamental flaw, but just a minor remark.

A new proposal based on segmentation coefficients.

Our proposal is based on a set of segmentation coefficients SC_{F_n} . There are F_{\max} segmentation coefficients for each possible TTI duration in the CCTrCH.

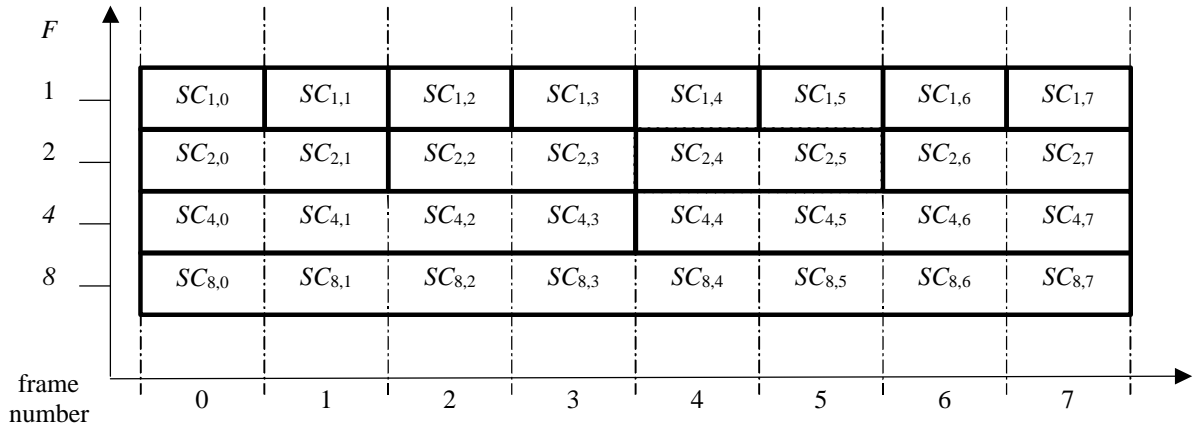
- The index F tells the TTI durations: $F \in \{1,2,4,8\}$.

- The index n identifies one radio frame within the longest TTI: $n \in \{0, 1, \dots, F_{\max} - 1\}$,

The segmentation coefficient $SC_{F,m-F+n}$ gives for any TrCH of TTI with a duration of F radio frames, for the TTI number m within the largest TTI, and for the radio frame number n within this TTI number m , the proportion of data falling into the corresponding segment. Hence, the segmentation coefficients are positive numbers summing up to 1 within one TTI, and therefore we have the following equation that by definition is always held:

$$\forall m \in \left\{ 0, 1, \dots, \frac{F_{\max}}{F} - 1 \right\} \left(\forall F \in \{1, 2, 4, 8\} \right) \sum_{n=0}^{n=F-1} SC_{F,m-F+n} = 1$$

This is summarised by the figure below where we assume that all TTI duration $F \in \{1, 2, 4, 8\}$ are used (and so $F_{\max} = 8$). The segmentation coefficients summing up to 1 are placed in the same bold outline box.



Note that equal segmentation of TTI number m for TTI duration F equates to the following relation:

$$\forall n \in \{0, 1, \dots, F - 1\} SC_{F,m-F+n} = \frac{1}{F}$$

The rate matching can be determined in a very similar way as in the normal mode scheme, except for this that the $\frac{1}{F}$ factor is replaced by $SC_{F,m,n}$.

Determination of segmentation coefficients.

In this proposal we assume that the segmentation coefficient are signalled from the higher layers, that is from the network to the UE.

However, if required by other delegates we can present the methods that can be used in order to compute them.

Open items

- Dynamic and granularity of segmentation coefficient : we propose from 0 to $1-2^{-10}$ by steps of 2^{-10} as a working assumption
- Whether segmentation coefficients are to be signalled or calculated in both end. For the time being we propose signalled as a working assumption.

Conclusion

We propose the draft CR given in the sequel, to be taken as a basis for the CM by puncturing working assumption.

CHANGE REQUEST

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25.212 CR xxx

Current Version: **3.1.1**

GSM (AA.BB) or 3G (AA.BBB) specification number ↑

↑ CR number as allocated by MCC support team

For submission to: **WG1 # 11**

list expected approval meeting # here

↑

for approval

for information

strategic (for SMG use only)

non-strategic

Form: CR cover sheet, version 2 for 3GPP and SMG The latest version of this form is available from: <ftp://ftp.3gpp.org/Information/CR-Form-v2.doc>

Proposed change affects: (U)SIM ME UTRAN / Radio Core Network
(at least one should be marked with an X)

Source: Mitsubishi Electric **Date:**

Subject: Downlink Compressed Mode by puncturing

Work item: TS 25.212

Category: F Correction **Release:** Phase 2
(only one category shall be marked with an X) A Corresponds to a correction in an earlier release Release 96
B Addition of feature Release 97
C Functional modification of feature Release 98
D Editorial modification Release 99
Release 00

Reason for change: Introduction of a method for compressed mode by puncturing, by use of segmentation coefficients.

Clauses affected: To be completed

Other specs affected: Other 3G core specifications → List of CRs:
Other GSM core specifications → List of CRs:
MS test specifications → List of CRs:
BSS test specifications → List of CRs:
O&M specifications → List of CRs:

Other comments: ΔN_{\max} has been renamed $\Delta N_{i,\max}^{TTI}$ because it was commented by some delegates that the ΔN_{\max} notation was confusing.
 R_i and C_i have been renamed RI and CI because C_i interferes with C_i when $i = I$



help.doc

<----- double-click here for help and instructions on how to create a CR.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

\hat{x}	round towards \mathbb{N} , i.e. integer such that $x \leq \hat{x} < x+1$
\tilde{x}	round towards $-\mathbb{N}$, i.e. integer such that $x-1 < \tilde{x} \leq x$
$ x $	absolute value of x
N_{first}	The first slot in the TG .
N_{last}	The last slot in the TG . N_{last} is either a slot in the same radio frame as N_{first} or a slot in the radio frame immediately following the slot that contains N_{first} .

Unless otherwise is explicitly stated when the symbol is used, the meaning of the following symbols is:

i	TrCH number
j	TFC number
k	Bit number
l	TF number
m	Transport block number
n_i	Radio frame number of TrCH i .
p	PhCH number
r	Code block number
I	Number of TrCHs in a CCTrCH.
C_i	Number of code blocks in one TTI of TrCH i .
F_i	Number of radio frames in one TTI of TrCH i .
M_i	Number of transport blocks in one TTI of TrCH i .
P	Number of PhCHs used for one CCTrCH.
PL	Puncturing Limit for the uplink. Signalled from higher layers
RM_i	Rate Matching attribute for TrCH i . Signalled from higher layers.
$SC_{F,n}$	<u>DL compressed mode Segmentation coefficient for TTI duration F in radio frame count, and radio frame number n within largest TTI ($0 \leq n \leq F_{max}$).</u>
$H_i^{cm,n}$	<u>DL segment size for TrCH i, and for radio frame number n within longest TTI.</u>

Temporary variables, i.e. variables used in several (sub)sections with different meaning.

x, X
 y, Y
 z, Z

4.2.5 1st interleaving

4.2.5.1 1st interleaver operation

The 1st interleaving is a block interleaver with inter-column permutations. The input bit sequence to the 1st interleaver is denoted by $x_{i1}, x_{i2}, x_{i3}, \dots, x_{iX_i}$, where i is TrCH number and X_i the number of bits (at this stage X_i is assumed and guaranteed to be an integer multiple of TTI). The output bit sequence is derived as follows:

(1) ~~Select the number of columns C_i from table 3.~~ Set the number CI of columns to F_i

(2) ~~(2)~~ Determine the number of rows RI defined as

for downlink

$$RI = X_i / C_i = H_i \text{ in normal mode}$$

$$RI = \max_{m \cdot F_i \leq n < (m+1) \cdot F_i} H_i^{cm,n}$$

for uplink

$$RI = X_i / CI$$

(3) In DL compressed mode by puncturing, mark some positions in the $RI \times CI$ rectangular matrix as "p-bits", the other positions being marked as "non p-bits". The positions marked as "p-bits" are the

$$RI - H_i^{cm, m \cdot F_i + n'} \text{ last positions of column number } n+1, \text{ where } n' = BR_{F_i}(n).$$

In UL or normal mode, all positions in the $RI \times CI$ rectangular matrix are marked as "non p-bits"

(34) Write the input bit sequence from $x_{i,1}$ to x_{i,X_i} into the ~~$R_i \times C_i$~~ $RI \times CI$ rectangular matrix row by row starting with bit $x_{i,1}$ in the first column of the first row and ending with bit $x_{i,(R_i C_i)}$ in column CI of row RI , and excluding any positions that is marked as a "p-bit". For instance when no position is marked as a p-bit we get the following ∴

$$\begin{bmatrix} x_{i1} & x_{i2} & x_{i3} & \dots & x_{iCI} \\ x_{i,(CI+1)} & x_{i,(CI+2)} & x_{i,(CI+3)} & \dots & x_{i,(2CI)} \\ \vdots & \vdots & \vdots & \dots & \vdots \\ x_{i,((RI-1)CI+1)} & x_{i,((RI-1)CI+2)} & x_{i,((RI-1)CI+3)} & \dots & x_{i,(RI \cdot CI)} \end{bmatrix}$$

$$\begin{bmatrix} x_{i1} & x_{i2} & x_{i3} & \dots & x_{iC_I} \\ x_{i,(C_I+1)} & x_{i,(C_I+2)} & x_{i,(C_I+3)} & \dots & x_{i,(2C_I)} \\ \vdots & \vdots & \vdots & \dots & \vdots \\ x_{i,((R_I-1)C_I+1)} & x_{i,((R_I-1)C_I+2)} & x_{i,((R_I-1)C_I+3)} & \dots & x_{i,(R_I \cdot C_I)} \end{bmatrix}$$

(4) Perform the inter-column permutation based on the pattern $\{P_1(j)\}$ ($j=0,1, \dots, CI-1$) shown in table 3, where $P_1(j)$ is the original column position of the j -th permuted column. After permutation of the columns, the bits are denoted by y_{ik} from the first column of the first row and ending with bit in column C_j of row R_j , and excluding any positions that is marked as a "p-bit". For instance when no position is marked as a p-bit we get the following :

$$\begin{bmatrix} y_{i,1} & y_{i,(RI+1)} & y_{i,(2RI+1)} & \dots & y_{i,((CI-1)RI+1)} \\ y_{i,2} & y_{i,(RI+2)} & y_{i,(2RI+2)} & \dots & y_{i,((CI-1)RI+2)} \\ \vdots & \vdots & \vdots & \dots & \vdots \\ y_{i,RI} & y_{i,(2RI)} & y_{i,(3RI)} & \dots & y_{i,(CI \cdot RI)} \end{bmatrix} \begin{bmatrix} y_{i1} & y_{i,(R_I+1)} & y_{i,(2R_I+1)} & \dots & y_{i,((C_I-1)R_I+1)} \\ y_{i2} & y_{i,(R_I+2)} & y_{i,(2R_I+2)} & \dots & y_{i,((C_I-1)R_I+2)} \\ \vdots & \vdots & \vdots & \dots & \vdots \\ y_{iR_I} & y_{i,(2R_I)} & y_{i,(3R_I)} & \dots & y_{i,(C_I \cdot R_I)} \end{bmatrix}$$

(5) Read the output bit sequence $y_{i1}, y_{i2}, y_{i3}, \dots, y_{i,(CI \cdot RI)}$ ~~$y_{i1}, y_{i2}, y_{i3}, \dots, y_{i,(C_I \cdot R_I)}$~~ of the 1st interleaving column by column from the inter-column permuted $RI \times CI$ matrix and excluding positions marked as a "p-bit". Bit $y_{i,1}$ corresponds to the first row of the first column and bit $y_{i,(R_I \cdot C_I)}$ corresponds to row R_I of column C_I .

Table 3

TTI	Number of columns CI	Inter-column permutation patterns
10 ms	1	{0}
20 ms	2	{0,1}
40 ms	4	{0,2,1,3}
80 ms	8	{0,4,2,6,1,5,3,7}

4.2.5.2 1st IL algorithm in DL compressed mode by puncturing

In this section we give in more detail the algorithm for the 1st IL in DL compressed mode by puncturing

M is an array of $RI \cdot CI$ elements that is indexed from 0 to $RI \cdot CI - 1$

cbi is a count-down for each column counting the $\{0,1,\delta\}$ bits

So the algorithm is as follows :

-- initialisation of cbi count downs

for $n = 0$ to $CI - 1$ do

$$n' = BR_{F_i}(n)$$

$$cbi[n] = H_i^{cm, m \cdot F_i + n'}$$

end for


```

-- write-in
n = 0
k = 1
l = 0
while l = 0 to CI·RI-1 do
    if cbi[n] ≠ 0 then
        M[l] = xi,k
        k = k+1
        cbi[n] = cbi[n]-1
    else
        M[l] = p-bit
    end if
    n = n+1 mod CI
end for
-- read-out
k = 1
l = BRCI-1(0)
n = 0
do
    if M[l] ≠ p-bit then
        yi,k = M[l]
        k = k+1
    end-if
    l = l+CI
    if l ≥ CI·RI then
        n = n+1
        l = BRCI-1(n)
    endif
until l = BRCI-1(CI - 1) · RI - 1

```

4.2.5.13 Relation between input and output of 1st interleaving in uplink

The bits input to the 1st interleaving are denoted by $t_{i1}, t_{i2}, t_{i3}, \dots, t_{iT_i}$, where i is the TrCH number and T_i the number of bits. Hence, $x_{ik} = t_{ik}$ and $X_i = T_i$.

The bits output from the 1st interleaving are denoted by $d_{i1}, d_{i2}, d_{i3}, \dots, d_{iT_i}$, and $d_{ik} = y_{ik}$.

4.2.5.24 Relation between input and output of 1st interleaving in downlink

In normal mode $X_i = F_i H_i$ whereas in compressed mode by puncturing $X_i = \sum_{n=m \cdot F_i}^{n=(m+1) \cdot F_i - 1} H_i^{cm,n}$. H_i and $H_i^{cm,n}$ are determined in the rate matching sections 4.2.7.2.2.1. and 4.2.7.2.3.1.

If fixed positions of the TrCHs in a radio frame is used then the bits input to the 1st interleaving are denoted by $h_{i1}, h_{i2}, h_{i3}, \dots, h_{i,X_i}$ here X_i is defined as above, and where i is the TrCH number. Hence, $x_{ik} = h_{ik}$ and $X_i = F_i H_i$.

If flexible positions of the TrCHs in a radio frame is used then the bits input to the 1st interleaving are denoted by $g_{i1}, g_{i2}, g_{i3}, \dots, g_{i,G_i}$, where i is the TrCH number, and $G_i = X_i$ as defined above. Hence, $x_{ik} = g_{ik}$ and $X_i = G_i$.

The bits output from the 1st interleaving are denoted by $q_{i1}, q_{i2}, q_{i3}, \dots, q_{i,Q_i}$, where i is the TrCH number and Q_i is the number of bits. Hence, $q_{ik} = y_{ik}$, and $Q_i = Y_i = X_i$ and where X_i is defined as above $F_i H_i$ if fixed positions are used, and $Q_i = G_i$ if flexible positions are used.

The bits output from the 1st interleaving are denoted by $q_{i1}, q_{i2}, q_{i3}, \dots, q_{i,Q_i}$, where i is the TrCH number and Q_i is the number of bits. Hence, $q_{ik} = y_{ik}$, $Q_i = F_i H_i$ if fixed positions are used, and $Q_i = G_i$ if flexible positions are used.

4.2.6 Radio frame segmentation

When the transmission time interval is longer than 10 ms, the input bit sequence is segmented and mapped onto consecutive radio frames.

Following rate matching in the DL not in compressed mode by puncturing and radio frame size equalisation in the UL in compressed or normal loop, the input bit sequence length is guaranteed to be an integer multiple of F_i .

In the DL in compressed mode by puncturing the input bit sequence is not necessarily an integer multiple of F_i . Note that a TrCH TTI is concerned by this when the largest TTI containing it is overlapping with at least one transmission gap.

In other case than DL compressed mode by puncturing, the input bit sequence is denoted by $x_{i1}, x_{i2}, x_{i3}, \dots, x_{iX_i}$ where i is the TrCH number and X_i is the number bits. The F_i output bit sequences per TTI are denoted by $y_{i,n_1}, y_{i,n_2}, y_{i,n_3}, \dots, y_{i,n_{Y_i}}$ where n_i is the radio frame number in current TTI and Y_i is the number of bits per radio frame for TrCH i . The output sequences are defined as follows:

$$y_{i,n,k} = x_{i,(n_i \cdot Y_i) + k} \text{ where } n_i = 1 \dots Y_i, k = 1 \dots F_i$$

where

$Y_i = (X_i / F_i)$ is the number of bits per segment,

x_{ik} is the k^{th} bit of the input bit sequence and

$y_{i,n,k}$ is the k^{th} bit of the output bit sequence corresponding to the $n+1^{\text{th}}$ radio frame

The $(n+1)$ -th segment is mapped to the $(n+1)$ -th radio frame of the transmission time interval.

In DL, in compressed mode by puncturing,

$$y_{i,n_i,k} = x_{i,Z_{i,n_i}+k}, n_i=0..F_i-1, k=1..Y_i$$

where

$Y_i = H_i^{cm,m \cdot F_i + n_i}$ is the number of bits in segment with number n_i .

x_{ik} is the k^{th} bit of the input bit sequence and

$y_{i,n,k}$ is the k^{th} bit of the output bit sequence corresponding to the n^{th} radio frame

$$Z_{i,n_i} = \sum_{n=0}^{n_i-1} Y_i \text{ is the cumulated size of the previous segments}$$

The (n_i+1) -th segment is mapped to the (n_i+1) -th radio frame of the transmission time interval.

4.2.6.1 Relation between input and output of the radio frame segmentation block in uplink

The input bit sequence to the radio frame segmentation is denoted by $d_{i1}, d_{i2}, d_{i3}, \dots, d_{iT_i}$, where i is the TrCH number and T_i the number of bits. Hence, $x_{ik} = d_{ik}$ and $X_i = T_i$.

The output bit sequence corresponding radio frame n_i is denoted by $e_{i1}, e_{i2}, e_{i3}, \dots, e_{iN_i}$, where i is the TrCH number and N_i is the number of bits. Hence, $e_{i,k} = y_{i,n,k}$ and $N_i = Y_i$.

4.2.6.2 Relation between input and output of the radio frame segmentation block in downlink

The bits input to the radio frame segmentation are denoted by $q_{i1}, q_{i2}, q_{i3}, \dots, q_{iQ_i}$, where i is the TrCH number and Q_i the number of bits. Hence, $x_{ik} = q_{ik}$ and $X_i = Q_i$.

The output bit sequence corresponding to radio frame n_i is denoted by $f_{i1}, f_{i2}, f_{i3}, \dots, f_{iV_i}$, where i is the TrCH number and V_i is the number of bits. Hence, $f_{i,k} = y_{i,n,k}$ and $V_i = Y_i$.

4.2.7 Rate matching

Rate matching means that bits on a transport channel are repeated or punctured. Higher layers assign a rate-matching attribute for each transport channel. This attribute is semi-static and can only be changed through higher layer signalling. The rate-matching attribute is used when the number of bits to be repeated or punctured is calculated.

The number of bits on a transport channel can vary between different transmission time intervals. In the downlink the transmission is interrupted if the number of bits is lower than maximum. When the number of bits between different transmission time intervals in uplink is changed, bits are repeated or punctured to ensure that the total bit rate after TrCH multiplexing is identical to the total channel bit rate of the allocated dedicated physical channels.

If no bits are input to the rate matching for all TrCHs within a CCTrCH, the rate matching shall output no bits for all TrCHs within the CCTrCH and no uplink DPDCH will be selected in the case of uplink rate matching.

Notation used in section 4.2.7 and subsections:

N_{ij} : For uplink: Number of bits in a radio frame before rate matching on TrCH i with transport format combination j .

————— For downlink : An intermediate calculation variable (not an integer but a multiple of 1/8).

N_{il}^{TTI} : Number of bits in a transmission time interval before rate matching on TrCH i with transport format l .
Used in downlink only.

ΔN_{ij} : For uplink: If positive - number of bits that should be repeated in each radio frame on TrCH i with transport format combination j .

If negative - number of bits that should be punctured in each radio frame on TrCH i with transport format combination j .

For downlink : An intermediate calculation variable (not an integer but a multiple of 1/8).

ΔN_{il}^{TTI} : If positive - number of bits to be repeated in each transmission time interval on TrCH i with transport format j .

————— If negative - number of bits to be punctured in each transmission time interval on TrCH i with transport format j .

Used in downlink only.

$N_{data}^{cm,n}$, * $n=0$ to $F_{max}-1$: in the DL, total number of bits available to the CCTrCH in a radio frame such that the longest TTI in use is overlapping with a compressed mode gap. n is the frame number within this longest TTI.

RM_i : Semi-static rate matching attribute for transport channel i . Signalled from higher layers.

PL : Puncturing limit for uplink. This value limits the amount of puncturing that can be applied in order to avoid multicode or to enable the use of a higher spreading factor. Signalled from higher layers.

$N_{data,j}$: Total number of bits that are available for the CCTrCH in a radio frame with transport format combination j .

I : ————— Number of TrCHs in the CCTrCH.

Z_{ij} : ————— Intermediate calculation variable.

F_i : ————— Number of radio frames in the transmission time interval of TrCH i .

F_{max} Maximum number of radio frames in a transmission time interval used in the CCTrCH :

$$F_{max} = \max_{1 \leq i \leq I} F_i$$

n_i : Radio frame number in the transmission time interval of TrCH i ($0 \leq n_i < F_i$).

q : Average puncturing or repetition distance (normalised to only show the remaining rate matching on top of an integer number of repetitions). Used in uplink only.

$I_F(n_i)$: The inverse interleaving function of the 1st interleaver (note that the inverse interleaving function is identical to the interleaving function itself for the 1st interleaver). Used in uplink only.

$S(n_i)$: The shift of the puncturing or repetition pattern for radio frame n_i . Used in uplink only.

$TF_i(j)$: Transport format of TrCH i for the transport format combination j .

$TFS(i)$ The set of transport format indexes l for TrCH i .

$TFCS$ ————— The set of transport format combination indexes j : for normal mode.

TFCS^{cm,n} The set of transport format combination indexes *j* for compressed mode, and for radio frame number *n* within the largest TTI : $0 \leq n \leq F_{\max}$. This may differ from *TFCS* when higher layer scheduling is used.

- e*_{ini} Initial value of variable *e* in the rate matching pattern determination algorithm of section 4.2.7.5.
- e*_{plus} Increment of variable *e* in the rate matching pattern determination algorithm of section 4.2.7.5.
- e*_{minus} Decrement of variable *e* in the rate matching pattern determination algorithm of section 4.2.7.5.
- b*: Indicates systematic and parity bits
- b*=1: Systematic bit. *X*(*t*) in section 4.2.3.2.1.
- b*=2: 1st parity bit (from the upper Turbo constituent encoder). *Y*(*t*) in section 4.2.3.2.1.
- b*=3: 2nd parity bit (from the lower Turbo constituent encoder). *Y'*(*t*) in section 4.2.3.2.1.

The * (star) notation is used to replace an index *x* when the indexed variable *X_x* does not depend on the index *x*. In the left wing of an assignment the meaning is that "*X* = Y*" is equivalent to "**for all *x* do *X_x = Y***". In the right wing of an assignment, the meaning is that "*Y = X**" is equivalent to "**take any *x* and do *Y = X_x***".

The following relations, defined for all TFC *j*, are used when calculating the rate matching parameters:

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

$$Z_{ij} = \left[\frac{\sum_{m=1}^i RM_m \cdot N_{mj}}{\sum_{m=1}^I RM_m \cdot N_{mj}} \cdot N_{data,j} \right] \text{ for all } i = 1 \dots I \quad (1)$$

$$\Delta N_{ij} = Z_{ij} - Z_{i-1,j} - N_{ij} \quad \text{for all } i = 1 \dots I$$

4.2.7.1 Determination of rate matching parameters in uplink

4.2.7.1.1 Determination of SF and number of PhCHs needed

In uplink, puncturing can be applied to match the CCTrCH bit rate to the PhCH bit rate. The bit rate of the PhCH(s) is limited by the UE capability and restrictions imposed by UTRAN, through limitations on the PhCH spreading factor. The maximum amount of puncturing that can be applied is signalled from higher layers and denoted by *PL*. The number of available bits in the radio frames for all possible spreading factors is given in [2]. Denote these values by *N*₂₅₆, *N*₁₂₈, *N*₆₄, *N*₃₂, *N*₁₆, *N*₈, and *N*₄, where the index refers to the spreading factor. The possible values of *N*_{data} then are { *N*₂₅₆, *N*₁₂₈, *N*₆₄, *N*₃₂, *N*₁₆, *N*₈, *N*₄, 2*N*₄, 3*N*₄, 4*N*₄, 5*N*₄, 6*N*₄}. Depending on the UE capability and the restrictions from UTRAN, the allowed set of *N*_{data}, denoted SET0, can be a subset of { *N*₂₅₆, *N*₁₂₈, *N*₆₄, *N*₃₂, *N*₁₆, *N*₈, *N*₄, 2*N*₄, 3*N*₄, 4*N*₄, 5*N*₄, 6*N*₄}. *N*_{data,j} for the transport format combination *j* is determined by executing the following algorithm:

$$\text{SET1} = \{ N_{data} \text{ in SET0 such that } N_{data} - \sum_{x=1}^I \frac{RM_x}{\min_{1 \leq y \leq I} \{RM_y\}} \cdot N_{x,j} \text{ is non negative} \}$$

If SET1 is not empty and the smallest element of SET1 requires just one PhCH then

$$N_{data,j} = \min \text{SET1}$$

else

$$\text{SET2} = \{ N_{data} \text{ in SET0 such that } N_{data} - PL \cdot \sum_{x=1}^I \frac{RM_x}{\min_{1 \leq y \leq I} \{RM_y\}} \cdot N_{x,j} \text{ is non negative} \}$$

Sort SET2 in ascending order

$N_{data} = \min \text{SET2}$

While N_{data} is not the max of SET2 and the follower of N_{data} requires no additional PhCH do

$N_{data} = \text{follower of } N_{data} \text{ in SET2}$

End while

$N_{data,j} = N_{data}$

End if

4.2.7.1.2 Determination of parameters needed for calculating the rate matching pattern

The number of bits to be repeated or punctured, DN_{ij} , within one radio frame for each TrCH i is calculated with equation 1 for all possible transport format combinations j and selected every radio frame. $N_{data,j}$ is given from section 4.2.7.1.1.

In compressed mode $N_{data,j}$ is replaced by $N_{data,j}^{cm}$ in Equation 1. $N_{data,j}^{cm}$ is given from the following relation:

$N_{data,j}^{cm} = 2N_{data,j} - 2N_{TGL}$, for compressed mode by spreading factor reduction

$N_{data,j}^{cm} = N_{data,j} - N_{TGL}$, for compressed mode by higher layer scheduling

$$N_{TGL} = \begin{cases} \frac{TGL}{15} N_{data,j}, & \text{if } N_{first} + TGL \leq 15 \\ \frac{15 - N_{first}}{15} N_{data,j}, & \text{in first frame if } N_{first} + TGL > 15 \\ \frac{TGL - (15 - N_{first})}{15} N_{data,j}, & \text{in second frame if } N_{first} + TGL > 15 \end{cases}$$

N_{first} and TGL are defined in section 4.4.

If $DN_{ij} = 0$ then the output data of the rate matching is the same as the input data and the rate matching algorithm of section 4.2.7.5 does not need to be executed.

If $DN_{ij} \neq 0$ the parameters listed in sections 4.2.7.1.2.1 and 4.2.7.1.2.2 shall be used for determining e_{ini} , e_{plus} , and e_{minus} (regardless if the radio frame is compressed or not).

4.2.7.1.2.1 UNCODED AND CONVOLUTIONALLY ENCODED TRCHS

$R = DN_{ij} \bmod N_{ij}$ -- note: in this context $DN_{ij} \bmod N_{ij}$ is in the range of 0 to $N_{ij}-1$ i.e. $-1 \bmod 10 = 9$.

if $R \neq 0$ and $2R \leq N_{ij}$

then $q = \lceil N_{ij} / R \rceil$

else

$q = \lceil N_{ij} / (R - N_{ij}) \rceil$

endif

-- note: q is a signed quantity.

if q is even

then $q' = q + \gcd(|q|, F_i)/F_i$ -- where $\gcd(|q|, F_i)$ means greatest common divisor of $|q|$ and F_i

-- note that q' is not an integer, but a multiple of 1/8

else

$q' = q$

endif

for $x = 0$ to $F_i - 1$

$S(I_F(\lfloor \lfloor x * q' \rfloor \rfloor \bmod F_i)) = (\lfloor \lfloor x * q' \rfloor \rfloor \text{ div } F_i)$

end for

$\Delta N_i = \Delta N_{i,j}$

$a = 2$

For each radio frame, the rate-matching pattern is calculated with the algorithm in section 4.2.7.5, where :

$X_i = N_{i,j}$, and

$e_{\text{ini}} = (a \cdot S(n_i) \cdot |\Delta N_i| + 1) \bmod (a \cdot N_{i,j})$.

$e_{\text{plus}} = a \cdot N_{i,j}$

$e_{\text{minus}} = a \cdot |\Delta N_i|$

puncturing for $DN < 0$, repetition otherwise.

4.2.7.1.2.2 Turbo encoded TrCHs

If repetition is to be performed on turbo encoded TrCHs, i.e. $DN_{i,j} > 0$, the parameters in section 4.2.7.1.2.1 are used.

If puncturing is to be performed, the parameters below shall be used. Index b is used to indicate systematic ($b=1$), 1st parity ($b=2$), and 2nd parity bit ($b=3$).

$a=2$ when $b=2$

$a=1$ when $b=3$

$$\Delta N_i = \begin{cases} \lfloor \Delta N_{i,j} / 2 \rfloor, & b = 2 \\ \lfloor \Delta N_{i,j} / 2 \rfloor, & b = 3 \end{cases}$$

$X_i = \lfloor N_{i,j} / 3 \rfloor$,

$q = \lfloor X_i / |\Delta N_i| \rfloor$

if($q \leq 2$)

for $x=0$ to $F_i - 1$

$S[I_F((3x+b-1) \bmod F_i)] = x \bmod 2$;

end for

else

if q is even

then $q' = q - \text{gcd}(q, F_i) / F_i$ -- where $\text{gcd}(q, F_i)$ means greatest common divisor of q and F_i
-- note that q' is not an integer, but a multiple of 1/8

else $q' = q$

endif

for $x=0$ to $F_i - 1$

$r = \lfloor x * q' \rfloor \bmod F_i$;

$$S[\lfloor (3r+b-1) \bmod F_i \rfloor] = \lceil x * q \rceil \text{div } F_i;$$

endfor

endif

For each radio frame, the rate-matching pattern is calculated with the algorithm in section 4.2.7.5, where:

X_i is as above,

$$e_{\text{ini}} = (a \cdot S(n_i) \cdot |\Delta N_i| + X_i) \bmod (a \cdot X_i), \text{ if } e_{\text{ini}} = 0 \text{ then } e_{\text{ini}} = a \cdot X_i.$$

$$e_{\text{plus}} = a \cdot X_i$$

$$e_{\text{minus}} = a \cdot \lfloor \Delta N_i \rfloor$$

4.2.7.2 Determination of rate matching parameters in downlink

For downlink in normal mode $N_{\text{data},j}$ does not depend on the transport format combination j . $N_{\text{data},*}$ is given by the channelization code(s) assigned by higher layers.

For downlink in compressed mode, for the frame with number $n \in \{0, 1, \dots, F_{\text{max}} - 1\}$ relative to the longest CCTrCH's TTI overlapping with at least one compressed mode transmission gap we have

$$N_{\text{data},*}^{cm,n} = P \cdot N_{tr} \cdot (N_{\text{data}1} + N_{\text{data}2})$$

where $N_{\text{data}1}$ and $N_{\text{data}2}$ are the number of bits in the data fields of a slot for slot format A or B as defined in [2], and N_{tr} is the number of transmitted slot in the radio frame.

Note that $N_{\text{data},*}^{cm,n} = N_{\text{data},*}$ when frame n is not compressed.

In the following, the amount of puncturing or repetition for the TTI, as determined by the rate matching parameters provided by higher layers is calculated. In normal mode it is noted $\Delta N_{i,\text{max}}^{TTI}$ for fixed positions, and noted $\Delta N_{i,l}^{TTI}$ for flexible positions. Similarly, in compressed mode it is noted $\Delta N_{i,\text{max}}^{TTI,cm,m}$ for fixed positions, and noted $\Delta N_{i,l}^{TTI,cm,m}$ for flexible positions, where m stands for the TTI number within the largest TTI affected by at least a compressed mode transmission gap. $m \in \left\{ 0, 1, \dots, \frac{F_{\text{max}}}{F} \right\}$.

< Mitsubishi Note : be careful with this that $\Delta N_{i,\text{max}}^{TTI,cm,m}$ and $\Delta N_{i,l}^{TTI,cm,m}$ differ from the Nortel's $\Delta N_{cm,i,\text{max}}^{TTI}$ and $\Delta N_{cm,i,l}^{TTI}$ of tdoc R1-00-272. $\Delta N_{i,\text{max}}^{TTI,cm}$ and $\Delta N_{i,l}^{TTI,cm}$ are the amount of rate matching to be done, they don't need to be added up to the value computed in normal mode.>

Furthermore, the radio frame segment size, that is to say the amount of data falling into each radio frame is also determined. For TrCH i , and TF l , it is denoted $H_{i,l}$ for normal mode, and $H_{i,l}^{cm,n}$ for compressed. Index l meaning TF may be dropped when there is no ambiguity.

4.2.7.2.1 Determination of segmentation coefficients for DL compressed mode by puncturing

The $SC_{F,n}$ for all the TTI durations F used in the CCTrCH, and for all n from 0 to F_{\max} , are signalled from the higher layers.

4.2.7.2.42 Determination of rate matching parameters for fixed positions of TrCHs

4.2.7.2.2.1. Determination of segment size $H_{i,*}$ and puncture/repeat count $\Delta N_{i,\max}^{TTI}$ in normal mode

First an intermediate calculation variable $N_{i,*}$ is calculated for all transport channels i by the following formula:

$$N_{i,*} = \frac{1}{F_i} \cdot \max_{l \in TFS(i)} N_{i,l}^{TTI}$$

The computation of the $\Delta N_{i,l}^{TTI}$ parameters is then performed in for all TrCH i and all TF l by the following formula, where $\Delta N_{i,*}$ is derived from $N_{i,*}$ by the formula given at section 4.2.7:

$$\underline{H_{i,*} = N_{i,*} + \Delta N_{i,*}}$$

$$\Delta N_{i,\max}^{TTI} = F_i \cdot \Delta N_{i,*} \quad \underline{\Delta N_{\max} = F_i \cdot \Delta N_{i,*}}$$

4.2.7.2.2.2 Use of puncture/repeat count $\Delta N_{i,\max}^{TTI}$ or $\Delta N_{i,\max}^{TTI,cm,m}$ in fixed positions, both in normal and compressed mode, for the RM pattern setting

The parameter $\Delta N_{i,\max}^{TTI,cm,n}$ used in this section is determined in section 4.2.7.2.3.1.

In this section, in normal mode, we set

$$\Delta N_{i,\max} = \Delta N_{i,\max}^{TTI}$$

In compressed mode, for TTI number m within the largest TTI overlapping at least one transmission gap, we set that :

$$\Delta N_{i,\max} = \Delta N_{i,\max}^{TTI,cm,m}$$

Note that TTI number m does not necessarily overlap with one gap.

<Mitsubishi Note : in the rest of the fixed positions section the only changes are editorial, that is to say, replacement of ΔN_{\max} by $\Delta N_{i,\max}$, replacement of N_{\max} by $N_{i,\max}$, and also $e_{\min us}$ is replace by $e_{\min us}$ because all the "minus" was not in italic, since min is automatically put to function font by the MS-equation editor>

If $\Delta N_{i,\max} = 0$ ~~$\Delta N_{\max} = 0$~~ then, for TrCH i , the output data of the rate matching is the same as the input data and the rate matching algorithm of section 4.2.7.5 does not need to be executed. In this case we have :

$$\forall l \in TFS(i) \Delta N_{i,l}^{TTI} = 0$$

If $\Delta N_{i,\max} \neq 0$ ~~$\Delta N_{\max} \neq 0$~~ the parameters listed in sections 4.2.7.2.42.2.1 and 4.2.7.2.42.2.2 shall be used for determining e_{ini} , e_{plus} , and e_{minus} .

4.2.7.2.42.2.1 Uncoded and convolutionally encoded TrCHs

$$\Delta N_i = \Delta N_{i,\max} \quad \underline{\Delta N_i = \Delta N_{\max}}$$

$$a=2$$

$$N_{i,max} = \max_{l \in TFS(i)} N_{il}^{TTI} \quad N_{max} = \max_{l \in TFS(i)} N_{il}^{TTI}$$

For each transmission time interval of TrCH i with TF l , the rate-matching pattern is calculated with the algorithm in section 4.2.7.5. The following parameters are used as input:

$$X_i = N_{il}^{TTI}$$

$$e_{ini} = 1$$

$$e_{plus} = a \cdot N_{i,max} \quad e_{plus} = a \cdot N_{max}$$

$$e_{minus} = a \cdot |\Delta N_i|$$

Puncturing if $\Delta N_i < 0$, repetition otherwise. The values of $\Delta N_{i,l}^{TTI}$ may be computed by counting repetitions or puncturing when the algorithm of section 4.2.7.5 is run.

4.2.7.2.2.2 Turbo encoded TrCHs

If repetition is to be performed on turbo encoded TrCHs, i.e. $\Delta N_{i,max} > 0$, the parameters in section 4.2.7.2.2.1 are used.

If puncturing is to be performed, the parameters below shall be used. Index b is used to indicate systematic ($b=1$), 1st parity ($b=2$), and 2nd parity bit ($b=3$).

$$a=2 \text{ when } b=2$$

$$a=1 \text{ when } b=3$$

The bits indicated by $b=1$ shall not be punctured.

$$\Delta N_i = \begin{cases} \lfloor \Delta N_{i,max} / 2 \rfloor, & b = 2 \\ \lfloor \Delta N_{i,max} / 2 \rfloor, & b = 3 \end{cases} \quad \Delta N_i = \begin{cases} \lfloor \Delta N_{max} / 2 \rfloor, & b = 2 \\ \lfloor \Delta N_{max} / 2 \rfloor, & b = 3 \end{cases}$$

$$N_{i,max} = \max_{l \in TFS(i)} (N_{il}^{TTI} / 3) \quad N_{max} = \max_{l \in TFS(i)} (N_{il}^{TTI} / 3)$$

For each transmission time interval of TrCH i with TF l , the rate-matching pattern is calculated with the algorithm in section 4.2.7.5. The following parameters are used as input:

$$X_i = N_{il}^{TTI} / 3$$

$$e_{ini} = N_{i,max} \quad e_{ini} = N_{max}$$

$$e_{plus} = a \cdot N_{i,max} \quad e_{plus} = a \cdot N_{max}$$

$$e_{minus} = a \cdot |\Delta N_i| \quad e_{minus} = a \cdot |\Delta N_i|$$

The values of $\Delta N_{i,l}^{TTI}$ may be computed by counting repetitions or puncturing when the algorithm of section 4.2.7.5 is run.

4.2.7.2.23 Determination of rate matching parameters for flexible positions of TrCHs, and for fixed positions of TrCHs in compressed mode.

4.2.7.2.3.1 Determination of segment size ($H_{i,l}$, $H_{i,l}^{cm,n}$, $H_{i,*}^{cm,n}$) and puncture/repeat count

$$(\Delta N_{i,l}^{TTI}, \Delta N_{i,l}^{TTI,cm,m}, \Delta N_{i,max}^{TTI,cm,m})$$

First ~~an~~ intermediate calculation variables N_{ij} for normal mode, and $N_{i,j}^{cm,n}$ or $N_{i,*}^{cm,n}$ for compressed mode, isare calculated for all transport channels ~~i~~ , all transport format combinations j , and for compressed mode for all largest TTI-wise radio frame number n , by the following formulas:

$$N_{i,j} = \frac{1}{F_i} \cdot N_{i,TF_i(j)}^{TTI} \text{ in normal mode}$$

$$N_{i,j}^{cm,n} = SC_{F_i,n} \cdot N_{i,TF_i(j)}^{TTI} \text{ in compressed mode in flexible positions.}$$

$$N_{i,*}^{cm,n} = SC_{F_i,n} \cdot \max_{l \in TFS(i)} N_{i,l}^{TTI} \text{ in compressed mode in fixed positions.}$$

Then rate matching ratios RF_i for normal mode, and $RF_i^{cm,n}$ for compressed mode, are calculated for each the transport channel i in order to minimise the number of DTX bits when the bit rate of the CCTrCH is maximum. The RF_i and $RF_i^{cm,n}$ ratios are defined by the following formula:

$$RF_i = \frac{N_{data,*}}{\max_{j \in TFCS} \sum_{i=1}^{i=I} (RM_i \cdot N_{i,j})} \cdot RM_i$$

$$RF_i^{cm,n} = \frac{N_{data,*}^{cm,n}}{\max_{j \in TFCS^{cm,n}} \sum_{i=1}^{i=I} (RM_i \cdot N_{i,j}^{cm,n})} \cdot RM_i$$

Note that in the definition of $RF_i^{cm,n}$ in fixed positions, the operator $\max_{j \in TFCS^{cm,n}}$ needs not to be used as $N_{i,j}^{cm,n}$ is independent of j .

The computation of $\Delta N_{i,l}^{TTI}$ or $\Delta N_{i,l}^{TTI,cm,m}$ parameters is then performed in two phases. In a first phase, tentative temporary values of ~~$\Delta N_{i,l}^{TTI}$~~ segment sizes $H_{i,l}$ or $H_{i,l}^{cm,n}$ are computed, and in the second phase they are checked and corrected. The first phase, by use of the RF_i or $RF_i^{cm,n}$ ratios, ensures that the number of DTX indication bits inserted is minimum when the CCTrCH bit rate is maximum, but it does not ensure that the maximum CCTrCH bit rate is not greater than $N_{data,*}$ or $N_{data,*}^{cm,n}$ per 10ms. The latter condition is ensured through the checking and possible corrections carried out in the second phase.

At the end of the second phase, the latest value of $\Delta N_{i,l}^{TTI}$ is the definitive value.

The first phase defines the tentative temporary ~~$\Delta N_{i,l}^{TTI}$~~ $H_{i,l}$ or $H_{i,l}^{cm,n}$ for all transport channel i and any of its transport format l by use of the following formula:

$$H_{i,l} = \left[\frac{RF_i \cdot N_{i,l}^{TTI}}{F_i} \right] \cdot \Delta N_{i,l}^{TTI} = F_i \cdot \left[\frac{RF_i \cdot N_{i,l}^{TTI}}{F_i} \right] \cdot N_{i,l}^{TTI}$$

$$H_{i,l}^{cm,n} = \left[SC_{F_i,n} \cdot RF_i^{cm,n} \cdot N_{i,l}^{TTI} \right]$$

<Mitsubshi Note : **There is no change in the current rule.** The change below is not functional, this does the same thing. The objective is to have similar description in compressed mode and in normal mode

There was a correction in the comment "CCTrCH bit rate (bits per 10ms) for TFC j " where ' l ' was replaced by ' j ' >

The second phase is defined by the following algorithm in flexible position + normal mode:

for all j in $TFCS$ do

-- for all TFC

$$D = \sum_{i=1}^{i=l} H_{i,TF_i(j)} \quad \mathcal{D} = \sum_{i=1}^{i=l} \frac{N_{i,TF_i(j)}^{TTI} + \Delta N_{i,TF_i(j)}^{TTI}}{F_i}$$

-- CCTrCH bit rate (bits per 10ms) for TFC j

if $D > N_{data,*}$ then

for $i = 1$ to I do

-- for all TrCH

$$H = N_{i,j} + \Delta N_{i,j} \quad \Delta N = F_i \cdot \Delta N_{i,j}$$

given at section 4.2.7.

-- $\Delta N_{i,j}$ is derived from $N_{i,j}$ by the formula

if $H > H_{i,TF_i(j)} \quad \Delta N_{i,TF_i(j)}^{TTI} > \Delta N$ then

$$H_{i,TF_i(j)} = H \quad \Delta N_{i,TF_i(j)}^{TTI} = \Delta N$$

end-if

end-for

end-if

end-for

for $i=1$ to I do

for all l in $TFCS(i)$ do

$$\Delta N_{i,l}^{TTI} = F_i \cdot H_{i,l} - N_{i,l}^{TTI}$$

end-for

end-for

NOTE: The order in which the transport format combinations are checked does not change the final result.

The second phase is defined by the following algorithm in compressed mode:

for all $n = 0$ to $F_{\max}-1$ do

for all j in $TFCS^{cm,n}$ do -- for all TFC, in fixed positions, this loop can be omitted.

$$D = \sum_{i=1}^{I} H_{i,TF_i(j)}^{cm,n} \quad \text{-- CCTrCH bit rate (bits per 10ms) for TFC } j$$

if $D > N_{data,*}^{cm,n}$ then

for $i = 1$ to I do -- for all TrCH

$$H = N_{i,j}^{cm,n} + \Delta N_{i,j} \quad \text{-- } \Delta N_{i,j} \text{ is derived from } N_{i,j}^{cm,n} \text{ by the formula given at section 4.2.7 where}$$

$$N_{i,j}^{cm,n} \text{ is substituted to } N_{i,j} \text{ and } N_{data,*}^{cm,n} \text{ to } N_{data,j}.$$

if $H > H_{i,TF_i(j)}^{cm,n}$ then

$$H_{i,TF_i(j)}^{cm,n} = H$$

end-if

end-for

end-if

end-for

Now, for compressed mode with flexible position we make the following computations

for $i=1$ to I do

for all $m = 0$ to $\frac{F_i}{F_{\max}} - 1$ do

for all l in $TFS(i)$ do

$$\Delta N_{i,l}^{TTI,cm,m} = \left(\sum_{n=m \cdot F_i}^{n=(m+1) \cdot F_i - 1} H_{i,l}^{cm,n} \right) - N_{i,l}^{TTI}$$

end-for

end-for

end-for

NOTE: In flexible position, the order in which the transport format combinations are checked does not change the final result.

For compressed mode in fixed positions we make the following computations :

for $i=1$ to I do

for all $m = 0$ to $\frac{F_i}{F_{\max}} - 1$ do

$$N_{i,\max} = \max_{l \in TFS(i)} N_{i,l}^{TTI}$$

$$\Delta N_{i,\max}^{TTI,cm,m} = \left(\sum_{n=m \cdot F_i}^{n=(m+1) \cdot F_i - 1} H_{i,*}^{cm,n} \right) - N_{i,\max}$$

end-for

end-for

4.2.7.2.3.2 Use of puncture/repeat count $\Delta N_{i,l}^{TTI}$ or $\Delta N_{i,l}^{TTI,cm,m}$ in flexible positions, both in normal and compressed mode, for the RM pattern setting

In the following the explanation given with $\Delta N_{i,l}^{TTI}$ for normal mode, hold in the same way for compressed mode,

where to $\Delta N_{i,l}^{TTI}$ is to be substituted $\Delta N_{i,l}^{TTI,cm,m}$. In compressed mode m is the TTI number within the largest TTI

affected by at least one transmission gap, id est $m \in \left\{ 0, 1, \dots, \frac{F_{\max}}{F} - 1 \right\}$. Note that TTI number m does not

necessarily overlap with one gap.

If $\Delta N_{i,l}^{TTI} = 0$ then, for TrCH i at TF l , the output data of the rate matching is the same as the input data and the rate matching algorithm of section 4.2.7.5 does not need to be executed.

If $\Delta N_{i,l}^{TTI} \neq 0$ the parameters listed in sections 4.2.7.2.3.2.1 and 4.2.7.2.3.2.2 shall be used for determining e_{ini} , e_{plus} , and e_{minus} .

4.2.7.2.3.2.1 Uncoded and convolutionally encoded TrCHs

$$\Delta N_i = \Delta N_{il}^{TTI}$$

$$a=2$$

For each transmission time interval of TrCH i with TF l , the rate-matching pattern is calculated with the algorithm in section 4.2.7.5. The following parameters are used as input:

$$X_i = N_{il}^{TTI}$$

$$e_{ini} = 1$$

$$e_{plus} = a \cdot N_{il}^{TTI}$$

$$e_{minus} = a \cdot |\Delta N_i|$$

puncturing for $\Delta N_i < 0$, repetition otherwise.

4.2.7.2.23.2.2 Turbo encoded TrCHs

If repetition is to be performed on turbo encoded TrCHs, i.e. $\Delta N_{il}^{TTI} > 0$, the parameters in section 4.2.7.2.3.2.1 are used.

If puncturing is to be performed, the parameters below shall be used. Index b is used to indicate systematic ($b=1$), 1st parity ($b=2$), and 2nd parity bit ($b=3$).

$$a=2 \text{ when } b=2$$

$$a=1 \text{ when } b=3$$

The bits indicated by $b=1$ shall not be punctured.

$$\Delta N_i = \begin{cases} \left\lfloor \Delta N_{il}^{TTI} / 2 \right\rfloor, & b = 2 \\ \left\lfloor \Delta N_{il}^{TTI} / 2 \right\rfloor, & b = 3 \end{cases}$$

For each transmission time interval of TrCH i with TF l , the rate-matching pattern is calculated with the algorithm in section 4.2.7.5. The following parameters are used as input:

$$X_i = N_{il}^{TTI} / 3N,$$

$$e_{ini} = X_i,$$

$$e_{plus} = a \cdot X_i$$

$$e_{minus} = a \cdot \left| \Delta N_i \right|$$

