3GPP Meeting RAN WG1 meeting #11
San Diego, USA, 29 Feb - 03 Mar 2000

***Document* R1-000426**
e.g. for 3GPP use the format TP-99xxx
or for SMG, use the format P-99-xxx

CHANGE REQUEST

Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.

25.212	CR	059r1	Current Version:	V3.1.0

GSM (AA.BB) or 3G (AA.BBB) specification number ↑ *↑ CR number as allocated by MCC support team*

For submission to:	RAN #7	for approval	X	strategic		(for SMG use only)
list expected approval meeting # here ↑		for information		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: *(at least one should be marked with an X)* (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]

Source: Panasonic **Date:** 25 Feb 2000

Subject: Revision: Editorial correction to the calculation of Rate Matching parameters

Work item: TS25.212

Category: *(only one category shall be marked with an X)*

F	Correction		**Release:**	Phase 2	
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	X		Release 99	X
				Release 00	

Reason for change: In current specification, there is no description of calculating order of a * b /c. Result is sometimes incorrect accoding to the order of calculation.

Clauses affected:

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:

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

IPR2024-00985
Petitioners' Exhibit 1014
Page 000001

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.

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*.

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*.

IPR2024-00985
Petitioners' Exhibit 1014
Page 000002

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

TFCS The set of transport format combination indexes *j*.

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** $\underline{x}$ **do** $X_x = Y$ ". In the right wing of an assignment, the meaning is that "$Y = X_*$ " is equivalent to "**take any** $\underline{x}$ **and do** $Y = X_x$ "

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

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

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

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

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, $2N_4$, $3N_4$, $4N_4$, $5N_4$, $6N_4$}.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, $2N_4$, $3N_4$, $4N_4$, $5N_4$, $6N_4$}. $N_{data,j}$ for the transport format combination j is determined by executing the following algorithm:

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

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

$N_{data,j}$ = min SET1

else

IPR2024-00985
Petitioners' Exhibit 1014
Page 000003

SET2 = { N_{data} in SET0 such that $\min_{1 \le y \le I} \left\{ RM_y \right\} \cdot N_{data} - PL \cdot \sum_{x=1}^{I} RMx \cdot N_{x,j}$ is non negative }

Sort SET2 in ascending order

N_{data} = min SET2

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

N_{data} = follower of N_{data} 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

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

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

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

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

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

else

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

endif

IPR2024-00985
Petitioners' Exhibit 1014
Page 000004

-- 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 (| ⌊x*q'⌋ | mod F_i)) = (| ⌊x*q'⌋ | 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

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

$e_{plus} = a \cdot N_{ij}$

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

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

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

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

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

if($q \leq 2$)

for *x*=0 to F_i-1

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

end for

else

if *q* is even

IPR2024-00985
Petitioners' Exhibit 1014
Page 000005

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

$r = \lceil x*q' \rceil \bmod F_i$;

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

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,

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

$e_{plus} = a \cdot X_i$

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

4.2.7.2 Determination of rate matching parameters in downlink

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

4.2.7.2.1 Determination of rate matching parameters for fixed positions of TrCHs

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:

$$\Delta N_{max} = F_i \cdot \Delta N_{i,*}$$

If $\Delta N_{max} = 0$ 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 $\Delta N_{max} \neq 0$ the parameters listed in sections 4.2.7.2.1.1 and 4.2.7.2.1.2 shall be used for determining e_{ini}, e_{plus}, and e_{minus}.

4.2.7.2.1.1 Uncoded and convolutionally encoded TrCHs

$$\Delta N_i = \Delta N_{max}$$

a=2

IPR2024-00985
Petitioners' Exhibit 1014
Page 000006

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

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:

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

$$e_{ini} = 1$$

$$e_{plus} = a \cdot N_{max}$$

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

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.

4.2.7.2.1.2 Turbo encoded TrCHs

If repetition is to be performed on turbo encoded TrCHs, i.e. $\Delta N_{max} > 0$, the parameters in section 4.2.7.2.1.1 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

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

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

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

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:

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

$$e_{ini} = N_{max}$$

$$e_{plus} = a \cdot N_{max}$$

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

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.

4.2.7.2.2 Determination of rate matching parameters for flexible positions of TrCHs

First an intermediate calculation variable N_{ij} is calculated for all transport channels *i* and all transport format combinations *j* by the following formula:

IPR2024-00985
Petitioners' Exhibit 1014
Page 000007

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

Then rate matching ratios RF_i 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 ratios are defined by the following formula:

$$RF_i = \frac{N_{data,*}}{\max\limits_{j \in TFCS} \sum\limits_{i=1}^{i=I} \left(RM_i \cdot N_{i,j} \right)} \cdot RM_i$$

The computation of $\Delta N_{i,l}^{TTI}$ parameters is then performed in two phases. In a first phase, tentative temporary values of $\Delta N_{i,l}^{TTI}$ are computed, and in the second phase they are checked and corrected. The first phase, by use of the RF_i 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 $N_{data,*}$. 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 $\Delta N_{i,l}^{TTI}$ for all transport channel i and any of its transport format l by use of the following formula:

$$\Delta N_{i,l}^{TTI} = F_i \cdot \left\lceil \frac{RF_i \cdot N_{i,l}^{TTI}}{F_i \cdot} \right\rceil - N_{i,l}^{TTI} = F_i \cdot \left\lceil \frac{N_{data,*} \cdot RM_i \cdot N_{i,l}^{TTI}}{F_i \cdot \max\limits_{j \in TFCS} \sum\limits_{i=1}^{I} \left(RM_i \cdot N_{i,j} \right)} \right\rceil - N_{i,l}^{TTI}$$

The second phase is defined by the following algorithm:

for all j in *TFCS* do -- for all TFC

$D = \sum\limits_{i=1}^{i=I} \frac{N_{i,TF_i(j)}^{TTI} + \Delta N_{i,TF_i(j)}^{TTI}}{F_i}$ -- CCTrCH bit rate (bits per 10ms) for TFC l

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

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

$\Delta N = F_i \cdot \Delta N_{i,j}$ -- $\Delta N_{i,j}$ is derived from $N_{i,j}$ by the formula given at section 4.2.7.

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

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

end-if

end-for

end-if

end-for

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

IPR2024-00985
Petitioners' Exhibit 1014
Page 000008

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 4.2.7.2.2.1 and 4.2.7.2.2.2 shall be used for determining e_{ini}, e_{plus}, and e_{minus}.

4.2.7.2.2.1 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.

4.2.7.2.2.2 Turbo encoded TrCHs

If repetition is to be performed on turbo encoded TrCHs, i.e. $\Delta N_{il}^{TTI} > 0$, the parameters in section 4.2.7.2.2.1 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 $b=3$

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

$$\Delta N_i = \begin{cases} \lceil \Delta N_{il}^{TTI} / 2 \rceil, & b = 2 \\ \lceil \Delta N_{il}^{TTI} / 2 \rceil, & b = 3 \end{cases}$$

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:

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

$$e_{ini} = X_i,$$

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

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

IPR2024-00985
Petitioners' Exhibit 1014
Page 000009