3GPP TSG RAN WG1#9
Dresden, Germany 30 Nov - 03 Dec 1999

Document R1-99j98
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.

25.222	**CR**	**001rev3**	Current Version:	3.0.0

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

For submission to:	RAN #6	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	UTRAN / Radio	Core Network
	X	X	

Source: Siemens, LGIC **Date:** 30.11.99

Subject: Correction of rate matching parameters for repetition after 1st Interleaving in 25.222

Work item:

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

F	Correction	X
A	Corresponds to a correction in an earlier release	
B	Addition of feature	
C	Functional modification of feature	
D	Editorial modification	

Release:

Phase 2	
Release 96	
Release 97	
Release 98	
Release 99	X
Release 00	

Reason for change: For rate matching after first interleaving the formula was erroneous for high repetition rates.

Clauses affected: 4.2.7 Rate matching
4.2.7.1 Determination of rate matching parameters

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: Identical change should be introduced in 25.212 as well.
Revision 2: Editorial revision due to new CR-form and official version 3.0.0
Revision 3: Update of definition of q and $S(n_i)$ in section 4.2.7

4.2.7 Rate matching

Rate matching means that bits on a TrCH are repeated or punctured. Higher layers assign a rate-matching attribute for each TrCH. 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 TrCH can vary between different transmission time intervals. When the number of bits between different transmission time intervals is changed, bits are repeated to ensure that the total bit rate after second multiplexing is identical to the total channel bit rate of the allocated dedicated physical channels.

Notation used in section 4.2.7 and subsections:

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

ΔN_{ij} : If positive – number of bits to be repeated in each radio frame on TrCH *i* with transport format combination *j*.

If negative – number of bits to be punctured in each radio frame on TrCH *i* with transport format combination *j*.

RM_i: Semi-static rate matching attribute for TrCH *i*. Signalled from higher layers.

PL: Puncturing limit for uplink. This value limits the amount of puncturing that can be applied in order to minimise the number of dedicated physical channels. Signalled from higher layers.

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

I: Number of TrCHs in a CCTrCH.

Z_{mj}: 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 £* n_i < F_i).

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

$I_F(n_i)$: 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).

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

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

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

e_{ini}: Initial value of variable e in the rate matching pattern determination algorithm of section 4.2.7.3.

e_{plus} Increment of variable *e* in the rate matching pattern determination algorithm of section 4.2.7.3.

e_{minus} Decrement of variable *e* in the rate matching pattern determination algorithm of section 4.2.7.3.

X: Systematic bit in 4.2.3.2.1.

Y: 1st parity bit (from the upper Turbo constituent encoder) in section 4.2.3.2.1.

Y' 2nd parity bit (from the lower Turbo constituent encoder) in section 4.2.3.2.1.

NOTE: Time index t in 4.2.3.2.1 is omitted for simplify the rate matching description

4.2.7.1 Determination of rate matching parameters

The following relations are used when calculating the rate matching pattern:

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

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

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

Puncturing can be used to minimise the required transmission capacity. The maximum amount of puncturing that can be applied is signalled from higher layers and denoted by PL. The possible values for N_{data} in depend on the number of dedicated physical channels and on their characteristics (spreading factor, length of midamble and TFCI, usage of TPC and multiframe structure), respectively. The supported set of N_{data} , denoted SET0, depends on the UE capabilities.

$N_{data,\,j}$ for the transport format combination j is determined by executing the following algorithm:

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

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

The number of bits to be repeated or punctured, ΔN_{ij}, within one radio frame for each TrCH i is calculated with the relations given at the beginning of this section for all possible transport format combinations j and selected every radio frame.

If $\Delta N_{ij} = 0$ then the output data of the rate matching is the same as the input data and the rate matching algorithm of section 4.2.7.3 does not need to be executed.

Otherwise, the rate matching pattern is calculated with the algorithm described in section 4.2.7.3. For this algorithm the parameters e_{ini}, e_{plus}, e_{minus}, and N are needed, which are calculated according to the following equations:

For convolutional codes,

a = 2

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

$N = N_{i,j}$

$R = \Delta N_{ij} \bmod N_{ij}$ -- note: in this context $\Delta N_{ij} \bmod N_{ij}$ 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

-- note: q is a signed quantity.

~~$q = \lfloor N / (|\Delta N|) \rfloor$~~

If q is even

then $q' = q \ \underline{+}– \gcd(\lfloor q \rfloor, F_i)/F_i$ -- where $\gcd(\lfloor q \rfloor, F_i)$ means greatest common divisor of $\lfloor q \rfloor$ 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

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

e~~E~~nd for

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

$e_{plus} = a \cdot N$

$e_{minus} = a \times |DN|$

puncturing for DN<0, repeating otherwise.

For turbo codes, if repetition is to be performed, such as $DN_{i,j}$ >0, parameters for turbo codes are the same as parameter for convolutional codes. If puncturing is to be performed, parameters are as follows.

a = 2 for Y sequence, and

a = 1 for Y' sequence.

$$\Delta N = \begin{cases} \lfloor DN_{i,j} / 2 \rfloor \text{for Y sequence} \\ \lceil DN_{i,j} / 2 \rceil \text{for Y' sequence} \end{cases}$$

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

$q = \lfloor N / |\Delta N| \rfloor$

if($q \leq 2$)

for x=0 to F_i-1

if(Y sequence)

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

if(Y' sequence)

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

end for

else

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

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

if(Y sequence)