TSG-RAN Meeting #10 ***RP-000538***
Bangkok, Thailand, 6 - 8 December 2000

Title: **Agreed CRs to TS 25.212**

Source: **TSG-RAN WG1**

Agenda item: **5.1.3**

No.	R1 T-doc	Spec	CR	Rev	Subject	Cat	V_old	V_new
1	R1-001295	25.212	094	2	Correction of BTFD limitations	F	3.4.0	3.5.0
2	R1-001227	25.212	096	-	Compressed mode by puncturing	F	3.4.0	3.5.0
3	R1-001277	25.212	097	-	Clarification on the Ci formula	D	3.4.0	3.5.0
4	R1-001427	25.212	099	-	Editorial modification in RM section	F	3.4.0	3.5.0
5	R1-001477	25.212	100	1	Editorial corrections in TS 25.212	F	3.4.0	3.5.0
6	R1-001446	25.212	101	-	Correction to code block segmentation	F	3.4.0	3.5.0

3GPP TSG RAN Meeting #10
Bangkok, Thailand, 6-8, December 2000

Document *R1-00-1295*
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or for SMG, use the format P-99-xxx

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25.212	**CR**	**094r2**	Current Version:	3.4.0

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

For submission to:	RAN#10	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:	TSG RAN WG1	**Date:**	2000-10-11
Subject:	Correction of BTFD limitations		
Work item:			

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

Reason for change:	For the BLER estimation it must always be possible to detect if a transport block has been transmitted or not. Now this is not always possible to detect by a CRC check.
Clauses affected:	4.3

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:	

4.3 Transport format detection

If the transport format set of a TrCH *i* contains more than one transport format, the transport format can be detected according to one of the following methods:

- TFCI based detection: This method is applicable when the transport format combination is signalled using the TFCI field;
- explicit blind detection: This method typically consists of detecting the TF of TrCH *i* by use of channel decoding and CRC check;
- guided detection: This method is applicable when there is at least one other TrCH *i'*, hereafter called guiding TrCH, such that:
  - the guiding TrCH has the same TTI duration as the TrCH under consideration, i.e. $F_{i'} = F_i$;
  - different TFs of the TrCH under consideration correspond to different TFs of the guiding TrCH;
  - explicit blind detection is used on the guiding TrCH.

If the transport format set for a TrCH *i* contains one transport format only, no transport format detection needs to be performed for this TrCH.

For uplink, blind transport format detection is a network controlled option. For downlink, the UE shall be capable of performing blind transport format detection, if certain restrictions on the configured transport channels are fulfilled.

For a DPCH associated with a PDSCH, the DPCCH shall include TFCI.

4.3.1 Blind transport format detection

When no TFCI is available then explicit blind detection or guided detection shall be performed on all TrCHs within the CCTrCH that have more than one transport format. The UE shall only be required to support blind transport format detection if all of the following restrictions are fulfilled:

1. only one CCTrCH is received by the UE;~~.~~
2. the number of CCTrCH bits received per radio frame is 600 or less;
3. the number of transport format combinations of the CCTrCH is 64 or less;
4. fixed positions of the transport channels is used on the CCTrCH to be detectable~~ed~~;
5. convolutional coding is used on all explicitly detectable~~ed~~ TrCHs;
6. CRC with non-zero length is appended to all transport blocks on all explicitly detectable~~ed~~ TrCHs;
7. at least one transport block shall be transmitted per TTI on each explicitly detectable TrCH;

~~7~~8. the number of explicitly detectable~~ed~~ TrCHs is 3 or less;

~~8~~9. for all explicitly detectable~~ed~~ TrCHs *i*, the number of code blocks in one TTI (C_i) shall not exceed 1;

~~9~~10. the sum of the transport format set sizes of all explicitly ~~detected~~ detectable TrCHs, is 16 or less. The transport format set size is defined as the number of transport formats within the transport format set;

~~10~~11. there is at least one TrCH that can be used as the guiding transport channel for all transport channels using guided detection.

Examples of blind transport format detection methods are given in annex A.

4.3.2 Transport format detection based on TFCI

If a TFCI is available, then TFCI based detection shall be applicable to all TrCHs within the CCTrCH. The TFCI informs the receiver about the transport format combination of the CCTrCHs. As soon as the TFCI is detected, the transport format combination, and hence the transport formats of the individual transport channels are known.

3GPP TSG RAN Meeting #10
Bangkok, Thailand, 6-8, December 2000

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25.212 CR 096 Current Version: 3.4.0

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

For submission to: RAN#10
list expected approval meeting # here ↑

for approval	X	strategic		*(for SMG use only)*
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: (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]
(at least one should be marked with an X)

Source: TSG RAN WG1 **Date:** 2000-10

Subject: Compressed mode by puncturing

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: Some mistakes had been left in some calculations for compressed mode by puncturing. Corrections of formulas for rate matching calculations to cope with the slot format change in compressed frames, plus editorial mistakes, plus one clarification are proposed.

Clauses affected: 4.2.4, 4.2.5.4, 4.2.7.2, 4.2.9.1, 4.2.10

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:

4.2.4 Radio frame size equalisation

Radio frame size equalisation is padding the input bit sequence in order to ensure that the output can be segmented in F_i data segments of same size as described in subclause 4.2.7. Radio frame size equalisation is only performed in the UL (In normal mode and in compressed modes by SF reduction and by higher layer scheduling, DL rate matching output block length is always an integer multiple of F_i . In compressed mode by puncturing, first interleaver input block length after p-bits insertion is always an integer multiple of F_i).

The input bit sequence to the radio frame size equalisation is denoted by $c_{i1}, c_{i2}, c_{i3}, \ldots, c_{iE_i}$, where i is TrCH number and E_i the number of bits. The output bit sequence is denoted by $t_{i1}, t_{i2}, t_{i3}, \ldots, t_{iT_i}$, where T_i is the number of bits. The output bit sequence is derived as follows:

- $t_{ik} = c_{ik}$, for k = 1… E_i; and
- $t_{ik} = \{0, 1\}$ for k= E_i +1… T_i, if $E_i < T_i$;

where

- $T_i = F_i * N_i$; and
- $N_i = \lceil E_i / F_i \rceil$ is the number of bits per segment after size equalisation.

4.2.5 1st interleaving

In Compressed Mode by puncturing, bits marked with a fourth value on top of {0, 1, δ} and noted p, are introduced in the radio frames to be compressed, in positions corresponding to the first bits of the radio frames. They will be removed in a later stage of the multiplexing chain to create the actual gap. Additional puncturing has been performed in the rate matching step, over the TTI containing the compressed radio frame, to create room for these p-bits. The following subclause describes this feature.

4.2.5.1 Insertion of marked bits in the sequence to be input in first interleaver

In normal mode, compressed mode by higher layer scheduling, and compressed mode by spreading factor reduction:

$x_{i,k} = z_{i,k}$ and $X_i = Z_i$

In case the TTI contains a radio frame that is compressed by puncturing and fixed positions are used, sequence $x_{i,k}$ which will be input to first interleaver for TrCH i and TTI m within largest TTI, is built from bits $z_{i,k}$, $k=1, \ldots, Z_i$, plus $Np_{i,\max}^{TTI,m}$ bits marked p and $X_i = Z_i + Np_{i,\max}^{TTI,m}$, as is described thereafter.

$Np_{i,\max}^{TTI,m}$ is defined in the Rate Matching subclause 4.2.7.

$P1_{F_i}(x)$ defines the inter column permutation function for a TTI of length $F_i \times 10$ms, as defined in Table 3 in section 4.2.5.2. $P1_{F_i}(x)$ is the Bit Reversal function of x on $\log_2(F_i)$ bits.

NOTE 1: C[x], x= 0 to $F_i - 1$, the number of bits p which have to be inserted in each of the F_i segments of the TTI, where x is the column number before permutation, i.e. in each column of the first interleaver. $C[P1_{F_i}(x)]$ is equal to $Np_{i,\max}^{m \times F_i + x}$ for x equal 0 to $F_i - 1$ for fixed positions. It is noted $Np_i^{m \times F_i + x}$ in the following initialisation step.

NOTE 2: cbi[x], x=0 to $F_i - 1$, the counter of the number of bits p inserted in each of the F_i segments of the TTI, i.e. in each column of the first interleaver x is the column number before permutation.

col = 0

while col < F_i **do** -- here col is the column number after column permutation

C[$P1_{Fi}$(col)] = $Np_i^{m\times F_i+col}$ -- initialisation of number of bits p to be inserted in each of the F_i segments of the TTI number *m*

cbi[$P1_{Fi}$(col)] = 0 -- initialisation of counter of number of bits p inserted in each of the F_i segments of the TTI

col = col +1

end do

n = 0, m = 0

while n < X_i **do** -- from here col is the column number before column permutation

col = *n* mod F_i

if cbi[col] < C[col] **do**

$x_{i,n}$ = p -- insert one p bit

cbi[col] = cbi[col]+1 -- update counter of number of bits p inserted

else -- no more p bit to insert in this segment

$x_{i,n} = z_{i,,m}$

m = m+1

endif

n = n +1

end do

4.2.5.2 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 $x_{i,1}, x_{i,2}, x_{i,3}, \ldots, x_{i,X_i}$, 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 C1 from table 4.

(2) Determine the number of rows R1 defined as:

R1 = X_i / C1

(3) Write the input bit sequence into the R1 × C1 rectangular matrix row by row starting with bit $x_{i,1}$ in the first column of the first row and ending with bit $x_{i,(\mathrm{R1}\times\mathrm{C1})}$ in column C1 of row R1:

$$\begin{bmatrix} x_{i,1} & x_{i,2} & x_{i,3} & \ldots & x_{i,\mathrm{C1}} \\ x_{i,(\mathrm{C1}+1)} & x_{i,(\mathrm{C1}+2)} & x_{i,(\mathrm{C1}+3)} & \ldots & x_{i,(2\times\mathrm{C1})} \\ \vdots & \vdots & \vdots & \ldots & \vdots \\ x_{i,((\mathrm{R1}-1)\times\mathrm{C1}+1)} & x_{i,((\mathrm{R1}-1)\times\mathrm{C1}+2)} & x_{i,((\mathrm{R1}-1)\times\mathrm{C1}+3)} & \ldots & x_{i,(\mathrm{R1}\times\mathrm{C1})} \end{bmatrix}$$

(4) Perform the inter-column permutation based on the pattern $\left\langle \mathrm{P1}_{\mathrm{C1}}(j) \right\rangle_{j\in\{0,1,\ldots,\mathrm{C1}-1\}}$ shown in table 4, where $\mathrm{P1}_{\mathrm{C1}}(j)$ is the original column position of the *j*-th permuted column. After permutation of the columns, the bits are denoted by y_{ik}:

$$\begin{bmatrix} y_{i,1} & y_{i,(\mathrm{R1}+1)} & y_{i,(2\times\mathrm{R1}+1)} & \cdots y_{i,((\mathrm{C1}-1)\times\mathrm{R1}+1)} \\ y_{i,2} & y_{i,(\mathrm{R1}+2)} & y_{i,(2\times\mathrm{R1}+2)} & \cdots y_{i,((\mathrm{C1}-1)\times\mathrm{R1}+2)} \\ \vdots & \vdots & \vdots & \cdots \quad \vdots \\ y_{i,\mathrm{R1}} & y_{i,(2\times\mathrm{R1})} & y_{i,(3\times\mathrm{R1})} & \cdots \quad y_{i,(\mathrm{C1}\times\mathrm{R1})} \end{bmatrix}$$

(5) Read the output bit sequence $y_{i1}, y_{i2}, y_{i3}, \ldots, y_{i,(\mathrm{C1}\times\mathrm{R1})}$ of the 1st interleaving column by column from the inter-column permuted R1 × C1 matrix. Bit $y_{i,1}$ corresponds to the first row of the first column and bit $y_{i,(\mathrm{R1}\times\mathrm{C1})}$ corresponds to row R1 of column C1.

Table 4 Inter-column permutation patterns for 1st interleaving

TTI	Number of columns C1	Inter-column permutation patterns <$P1_{C1}(0)$, …, $P1_{C1}(C1-1)$>
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>

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

The bits input to the 1st interleaving are denoted by $t_{i,1}, t_{i,2}, t_{i,3}, \ldots, t_{i,T_i}$, where i is the TrCH number and T_i the number of bits. Hence, $z_{i,k} = t_{i,k}$ and $Z_i = T_i$.

The bits output from the 1st interleaving are denoted by $d_{i,1}, d_{i,2}, d_{i,3}, \ldots, d_{i,T_i}$, and $d_{i,k} = y_{i,k}$.

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

If fixed positions of the TrCHs in a radio frame is used then the bits input to the 1st interleaving are denoted by $\cancel{h_{i1}, h_{i2}, h_{i3}, \ldots, h_{i(F_iH_i)}}$ $h_{i1}, h_{i2}, h_{i3}, \ldots, h_{iD_i}$, where i is the TrCH number. Hence, $z_{ik} = h_{ik}$ and $Z_i = D_i$.

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

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

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 subcaluse 4.2.7 and subclauses:

$N_{i,j}$: 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).

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

$\Delta N_{i,j}$: 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).

$\Delta N_{i,l}^{TTI}$: If positive - number of bits to be repeated in each transmission time interval on TrCH *i* with transport format *l*.

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

Used in downlink only.

$Np_{i,l}^{TTI,m}$, $m=0$ *to* $(F_{max} / F_i) - 1$:Positive or null: number of bits to be removed in TTI number *m* within the largest TTI, to create the required gaps in the compressed radio frames of this TTI, in case of compressed mode by puncturing, for TrCH *i* with transport format *l*. In case of fixed positions and compressed mode by puncturing, this value is noted $Np_{i,\max}^{TTI,m}$ since it is calculated for all TrCH with their maximum number of bits; thus it is the same for all TFCs

Used in downlink only.

$Np_{i,l}^{n}$ $n=0$ *to* $F_{max}-1$:Positive or null: number of bits, in radio frame number *n* within the largest TTI, corresponding to the gap for compressed mode in this radio frame, for TrCH *i* with transport format *l*. The value will be null for the radio frames not overlapping with a transmission gap. In case of fixed positions and compressed mode by puncturing, this value is noted $Np_{i,\max}^{n}$ since it is calculated for all TrCHs with their maximum number of bits; thus it is the same for all TFCs

Used in downlink only.

$N_{TGL}[k]$, $k=0$ *to* $F_{\max}-1$: Positive or null: number of bits in each radio frame corresponding to the gap for compressed mode for the CCTrCH.

RM_i: Semi-static rate matching attribute for transport channel *i*. RM_i is provided by higher layers or takes a value as indicated in section 4.2.13.

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. The allowed puncturing in % is actually equal to (1-PL)*100.

$N_{data,j}$: 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.

$Z_{i,j}$: 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 :

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

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

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.

$P1_F(n_i)$: The column permutation function of the 1st interleaver, $P1_F(x)$ is the original position of column with number x after permutation. P1 is defined on table 4 of section 4.2.5.2 (note that the $P1_F$ is self-inverse). Used for rate matching in uplink only.

$S[n]$: The shift of the puncturing or repetition pattern for radio frame n_i when $n = P1_{F_i}(n_i)$. 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*.

e_{ini} Initial value of variable *e* in the rate matching pattern determination algorithm of subclause 4.2.7.5.

e_{plus} Increment of variable *e* in the rate matching pattern determination algorithm of subclause4.2.7.5.

e_{minus} Decrement of variable *e* in the rate matching pattern determination algorithm of subclause 4.2.7.5.

b: Indicates systematic and parity bits

b=1: Systematic bit. x_k in subclause 4.2.3.2.1.

b=2: 1st parity bit (from the upper Turbo constituent encoder). z_k in subcaluse 4.2.3.2.1.

b=3: 2nd parity bit (from the lower Turbo constituent encoder). z'_k in subclause 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:

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

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

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

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 1-PL, PL is signalled from higher layers. The number of available bits in the radio frames of one PhCH 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 number of bits available to the CCTrCH on all PhCHs, N_{data}, then are { N_{256}, N_{128}, N_{64}, N_{32}, N_{16}, N_8, N_4, $2\times N_4$, $3\times N_4$, $4\times N_4$, $5\times N_4$, $6\times N_4$}.

For a RACH CCTrCH SET0 represents the set of N_{data} values allowed by the UTRAN, as set by the minimum SF provided by higher layers. SET0 may be a sub-set of { N_{256}, N_{128}, N_{64}, N_{32} }. SET0 does not take into account the UE's capability.

For other CCTrCHs, SET0 denotes the set of N_{data} values allowed by the UTRAN and supported by the UE, as part of the UE's capability. SET0 can be a subset of { N_{256}, N_{128}, N_{64}, N_{32}, N_{16}, N_8, N_4, $2\times N_4$, $3\times N_4$, $4\times N_4$, $5\times N_4$, $6\times N_4$}. $N_{data,j}$ for the transport format combination j is determined by executing the following algorithm:

SET1 = { N_{data} in SET0 such that $\left(\min_{1\le y\le I}\{RM_y\}\right)\times N_{data} - \sum_{x=1}^{I} RM_x \times N_{x,j}$ 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

SET2 = { N_{data} in SET0 such that $\left(\min_{1\le y\le I}\{RM_y\}\right)\times N_{data} - PL \times \sum_{x=1}^{I} RM_x \times N_{x,j}$ 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

For a RACH CCTrCH, if $N_{data,j}$ is not part of the UE's capability then the TFC j cannot be used.

4.2.7.1.2 Determination of parameters needed for calculating the rate matching pattern

The number of bits to be repeated or punctured, $\Delta N_{i,j}$, 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 subclause 4.2.7.1.1.

In a compressed radio frame, $N_{data,j}$ is replaced by $N_{data,j}^{cm}$ in Equation 1. $N_{data,j}^{cm}$ is given as follows:

In a radio frame compressed by higher layer scheduling, $N_{data,j}^{cm}$ is obtained by executing the algorithm in subclause 4.2.7.1.1 but with the number of bits in one radio frame of one PhCH reduced to $\frac{N_{tr}}{15}$ of the value in normal mode.

N_{tr} is the number of transmitted slots in a compressed radio frame and is defined by the following relation:

$$N_{tr} = \begin{cases} 15 - TGL, \text{ if } N_{first} + TGL \le 15 \\ N_{first}, \text{ in first frame if } N_{first} + TGL > 15 \\ 30 - TGL - N_{first}, \text{ in second frame if } N_{first} + TGL > 15 \end{cases}$$

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

In a radio frame compressed by spreading factor reduction, $N_{data,j}^{cm} = 2 \times \left(N_{data,j} - N_{TGL}\right)$, where

$$N_{TGL} = \frac{15 - N_{tr}}{15} \times N_{data,j}$$

If $\Delta N_{i,j} = 0$ then the output data of the rate matching is the same as the input data and the rate matching algorithm of subclause 4.2.7.5 does not need to be executed.

If $\Delta N_{i,j} \neq 0$ the parameters listed in subclauses 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

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

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

then q = $\lceil N_{i,j} / R \rceil$

else

q = $\lceil N_{i,j} / (R - N_{i,j}) \rceil$

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[| $\lfloor x \times q' \rfloor$ | mod F_i] = (| $\lfloor x \times q' \rfloor$ | 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 subclause 4.2.7.5, where :

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

$e_{ini} = (a \times S[P1_{Fi}(n_i)] \times |\Delta N_i| + 1) \bmod (a \cdot N_{ij})$.

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

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

puncturing for ΔN <0, repetition otherwise.

4.2.7.1.2.2 Turbo encoded TrCHs

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

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

If ΔN_i is calculated as 0 for b=2 or b=3, then the following procedure and the rate matching algorithm of subclause 4.2.7.5 don't need to be performed for the corresponding parity bit stream.

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

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

```
if(q ≤ 2)
    for r=0 to Fi-1
        S[(3×r+b-1) mod FI] = r mod 2;
    end for
else
    if q is even
    then  q' = q – gcd( q, Fi)/ Fi   -- where gcd ( q, Fi) means greatest common divisor of q and Fi
        -- note that q' is not an integer, but a multiple of 1/8
    else     q' = q
    endif
    for x=0 to Fi -1
        r = ⌈x×q'⌉ mod Fi;
        S[(3×r+b-1) mod Fi] = ⌈x×q'⌉ div Fi;
    endfor
endif
```

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

X_i is as above:

e_{ini} = (a×S[P1$_{Fi}$(n_i)] ×|ΔN$_i$| + X$_i$) mod (a×X_i), if e_{ini} =0 then e_{ini} = a×X_i

e_{plus} = a×X_i

e_{minus} = a× $|\Delta N_i|$

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. Denote the number of physical channels used for the CCTrCH by P. $N_{data,*}$ is the number of bits available to the CCTrCH in one radio frame and defined as $N_{data,*}=P\times15\times(N_{data1}+N_{data2})$, where N_{data1} and N_{data2} are defined in [2]. Note that contrary to the uplink, the same rate matching patterns are used in TTIs containing no compressed radio frames and in TTIs containing radio frames compressed by spreading factor reduction or higher layer scheduling.

In the following, the total amount of puncturing or repetition for the TTI is calculated.

Additional calculations for TTIs containing radio frames compressed by puncturing in case fixed positions are used, are performed to determine this total amount of rate matching needed.

For compressed mode by puncturing, in TTIs where some compressed radio frames occur, the puncturing is increased or the repetition is decreased compared to what is calculated according to the rate matching parameters provided by higher layers. This allows to cope with reduction of available data bits on the physical channel(s) if the slot format for the compressed frame(s) contains fewer data bits than for the normal frames(s), and to create room for later insertion of marked bits, noted p-bits, which will identify the positions of the gaps in the compressed radio frames.

The amount of additional puncturing corresponds to the number of bits to create the gap in the TTI for TrCH i, plus the difference between the number of data bits available in normal frames and in compressed frames, due to slot format change. In case of fixed positions, it is calculated in addition to the amount of rate matching indicated by higher layers. It is noted $Np_{i,\max}^{TTI,m}$.

In fixed positions case, to obtain the total rate matching $\Delta N_{i,\max}^{TTI,cm,m}$ to be performed on the TTI m, $Np_{i,\max}^{TTI,m}$ is subtracted from $\Delta N_{i,\max}^{TTI,m}$ (calculated based on higher layers RM parameters as for normal rate matching). This allows to create room for the $Np_{i,\max}^{TTI,m}$ bits p to be inserted later. If the result is null, i.e. the amount of repetition matches exactly the amount of additional puncturing needed, then no rate matching is necessary.

In case of compressed mode by puncturing and fixed positions, for some calculations, $N'_{data,*}$ is used for radio frames with gap instead of $N_{data,*}$, where $N'_{data,*}=P\times15\times(N'_{data1}+N'_{data2})$. N'_{data1} and N'_{data2} are the number of bits in the data fields of the slot format used for the current compressed mode, i.e. slot format A or B as defined in [2] corresponding to the Spreading Factor and the number of transmitted slots in use.

The number of bits corresponding to the gap for TrCH i, in each radio frame of its TTI is calculated using the number of bits to remove on all Physical Channels N_{TGL}[k], where k is the radio frame number in the largest TTI.

For each radio frame k of the largest TTI that is overlapping with a transmission gap, N_{TGL}[k] is given by the relation:

$$N_{TGL}=\begin{cases}\dfrac{TGL}{15}\times N'_{data,*}\text{, if } N_{first}+TGL\le 15\\[2ex] \dfrac{15-N_{first}}{15}\times N'_{data,*}\text{, in first radio frame of the gap if } N_{first}+TGL>15\\[2ex] \dfrac{TGL-(15-N_{first})}{15}\times N'_{data,*}\text{, in second radio frame of the gap if } N_{first}+TGL>15\end{cases}$$

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

Note that N_{TGL} [k] = 0 if radio frame k is not overlapping with a transmission gap.

4.2.7.2.1 Determination of rate matching parameters for fixed positions of TrCHs

4.2.7.2.1.1 Calculation of $\Delta N_{i,\max}$ for normal mode and compressed mode by spreading factor reduction

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

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

In order to compute the $\Delta N_{i,l}^{TTI}$ parameters for all TrCH *i* and all TF *l*, we first compute an intermediate parameter $\Delta N_{i,\max}$ by the following formula, where $\Delta N_{i,*}$ is derived from $N_{i,*}$ by the formula given at subclause 4.2.7:

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

If $\Delta N_{i,max} = 0$ then, for TrCH *i*, the output data of the rate matching is the same as the input data and the rate matching algorithm of subclause 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 $\Delta N_{i,max} \neq 0$ the parameters listed in subclauses 4.2.7.2.1.3 and 4.2.7.2.1.4 shall be used for determining e_{ini}, e_{plus}, and e_{minus}, and $\Delta N_{i,l}^{TTI}$.

4.2.7.2.1.2 Calculations for compressed mode by puncturing

Calculations of $\Delta N_{i,\max}^{TTI,m}$ for all TTI *m* within largest TTI, for all TrCH *i*

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

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

Then an intermediate calculation variable $\cancel{\Delta N_{i,*}^{n}}$ $\Delta N_{i,*}$ is derived from $N_{i,*}$ by the formula given at subclause 4.2.7, for all TrCH *i* ~~and all frames *n* in the largest TTI, from the formula given at subclause 4.2.7 using $N_{data,*}$ when index *n* designates a radio frame of the largest TTI that is not overlapping with a transmission gap, and using $N'_{data,*}$ instead of $N_{data,*}$, when index *n* designate a frame that is overlapping with a transmission gap~~.

In order to compute the $\Delta N_{i,l}^{TTI,m}$ parameters for all TrCH *i*, all TF *l* and all TTI with number *m* in the largest TTI, we first compute an intermediate parameter $\Delta N_{i,\max}^{m}$ by the following formula :

$$\cancel{\Delta N_{i,\max}^{m} = \sum_{n=m\times F_i}^{n=(m+1)\times F_i - 1} \Delta N_{i,*}^{n}}\ \Delta N_{i,\max}^{m} = F_i \times \Delta N_{i,*}$$

Calculations of $Np_{i,\max}^{n}$ and $Np_{i,\max}^{TTI,m}$

Let $Np_{i,\max}^{n}$ be the number of bits to eliminate on TrCH *i* to create the gap for compressed mode and to cope for the reduction of the number of available data bits in the compressed frame if the changed slot format contains fewer data bits than for normal frame, in each radio frame ~~k~~ n of the TTI, calculated for the Transport Format Combination of TrCH *i*, in which the number of bits of TrCH *i* is at its maximum.

$Np_{i,\max}^{n}$ is calculated for each radio frame ~~k~~ n of the TTI in the following way.

Intermediate variables Z_i *for i = 1 to I* are calculated using the formula (1) in 4.2.7, by replacing $N_{data,j}$ by $(N_{TGL}[n] + (N_{data,*} - N'_{data,*}))$.

Then $Np_{i,\max}^{n}$ = $(Z_i - Z_{i-1})$ *for i = 1 to I*

The total number of bits $Np_{i,\max}^{TTI,m}$ corresponding to the gaps for compressed mode for TrCH i in the TTI is calculated as:

$$Np_{i,\max}^{TTI,m} = \sum_{n=m\times F_i}^{n=(m+1)\times F_i-1} Np_{i,\max}^{n}$$

The amount of rate matching $\Delta N_{i,\max}^{TTI,cm,m}$ for the highest TrCH bit rate is then computed by the following formula :

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

If $\Delta N_{i,\max}^{TTI,cm,m}$ = 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 subclause 4.2.7.5 does not need to be executed.

If $\Delta N_{i,\max}^{TTI,cm,m} \neq 0$, then, for TrCH *i*, the rate matching algorithm of subclause 4.2.7.5 needs to be executed, and the parameters listed in subclauses 4.2.7.2.1.3 and 4.2.7.2.1.4 shall be used for determining e_{ini}, e_{plus}, and e_{minus}, and $\Delta N_{i,l}^{TTI,m}$.

4.2.7.2.1.3 Determination of rate matching parameters for uncoded and convolutionally encoded TrCHs

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

For compressed mode by puncturing, ΔN_i is defined as: $\Delta N_i = \Delta N_{i,\max}^{TTI,cm,m}$, instead of the previous relation.

a=2

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

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

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

$$e_{ini} = 1$$

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

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

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 subclause 4.2.7.5 is run. The resulting values of $\Delta N_{i,l}^{TTI}$ can be represented with following expression.

$$\Delta N_{i,l}^{TTI} = \left\lceil \frac{|\Delta N_i| \times X_i}{N_{max}} \right\rceil \times \mathrm{sgn}(\Delta N_i)$$

For compressed mode by puncturing, the above formula produces $\Delta N_{i,l}^{TTI,m}$ instead of $\Delta N_{i,l}^{TTI}$.

4.2.7.2.1.4 Determination of rate matching parameters for Turbo encoded TrCHs

If repetition is to be performed on turbo encoded TrCHs, i.e. $\Delta N_{i,max} > 0$, the parameters in subclause 4.2.7.2.1.3 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.

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

In Compressed Mode by puncturing, the following relations are used instead of the previous ones:

$$\Delta N_i^b = \lfloor \Delta N_{i,\max}^{TTI,cm,m}/2 \rfloor, \text{ for } b=2$$

$$\Delta N_{i\ I}^b = \lceil \Delta N_{i,\max}^{TTI,cm,m}/2 \rceil, \text{ for } b=3$$

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

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

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

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

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

$$e_{minus} = a \times |\Delta N_i^b|$$

The values of $\Delta N_{i,l}^{TTI}$ may be computed by counting puncturing when the algorithm of subclause 4.2.7.5 is run. The resulting values of $\Delta N_{i,l}^{TTI}$ can be represented with following expression.

$$\Delta N_{i,l}^{TTI} = -\left\lfloor \frac{|\Delta N_i^2| \times X_i}{N_{max}} + 0.5 \right\rfloor - \left\lfloor \frac{|\Delta N_i^3| \times X_i}{N_{max}} \right\rfloor$$

In the above equation, the first term of the right hand side represents the amount of puncturing for *b*=2 and the second term represents the amount of puncturing for *b*=3.

For compressed mode by puncturing, the above formula produces $\Delta N_{i,l}^{TTI,m}$ instead of $\Delta N_{i,l}^{TTI}$.

4.2.9 Insertion of discontinuous transmission (DTX) indication bits

In the downlink, DTX is used to fill up the radio frame with bits. The insertion point of DTX indication bits depends on whether fixed or flexible positions of the TrCHs in the radio frame are used. It is up to the UTRAN to decide for each CCTrCH whether fixed or flexible positions are used during the connection. DTX indication bits only indicate when the transmission should be turned off, they are not transmitted.

4.2.9.1 1st insertion of DTX indication bits

This step of inserting DTX indication bits is used only if the positions of the TrCHs in the radio frame are fixed. With fixed position scheme a fixed number of bits is reserved for each TrCH in the radio frame.

The bits from rate matching are denoted by $g_{i1}, g_{i2}, g_{i3}, \ldots, g_{iG_i}$, where G_i is the number of bits in one TTI of TrCH i. Denote the number of bits in one radio frame of TrCH i by H_i. Denote D_i the number of bits output of the first DTX insertion block.

In TTIs containing no compressed frames or frames compressed by spreading factor reduction, H_i is constant and corresponds to the maximum number of bits from TrCH i in one radio frame for any transport format of TrCH i and $D_i = F_i \times H_i$.

In TTIs containing frames compressed by puncturing, additional puncturing is performed in the rate matching block. The empty positions resulting from the additional puncturing are used to insert p-bits in the first interleaving block, the DTX insertion is therefore limited to allow for later insertion of p-bits. Thus DTX bits are inserted until the total number of bits is Di where $D_i = F_i \times H_{i,*} - Np^{TTI,\, m}_{i,max}$, and $H_i = N_{i,*} + \Delta N_{i,*}$.

The bits output from the DTX insertion are denoted by $h_{i1}, h_{i2}, h_{i3}, \ldots, h_{iD_i}$ Note that these bits are three valued. They are defined by the following relations:

$$h_{ik} = g_{ik} \quad k = 1, 2, 3, \ldots, G_i$$

$$h_{ik} = \delta \quad k = G_i+1, G_i+2, G_i+3, \ldots, D_i$$

where DTX indication bits are denoted by δ. Here $g_{ik} \in \{0, 1\}$ and $\delta \notin \{0, 1\}$.

4.2.9.2 2nd insertion of DTX indication bits

The DTX indication bits inserted in this step shall be placed at the end of the radio frame. Note that the DTX will be distributed over all slots after 2nd interleaving.

The bits input to the DTX insertion block are denoted by $s_1, s_2, s_3, \ldots, s_S$,where S is the number of bits from TrCH multiplexing. The number of PhCHs is denoted by P and the number of bits in one radio frame, including DTX indication bits, for each PhCH by R..

In non-compressed frames, $R = \frac{N_{data,*}}{P} = 15 \times \left(N_{data1} + N_{data2}\right)$, where N_{data1} and N_{data2} are defined in [2].

For compressed frames, $N'_{data,*}$ is defined as $N'_{data,*} = P \times 15 \times (N'_{data1} + N'_{data2})$. N'_{data1} and N'_{data2} are the number of bits in the data fields of the slot format used for the current compressed frame, i.e. slot format A or B as defined in [2] corresponding to the spreading factor and the number of transmitted slots in use.

In frames compressed by puncturing and when fixed positions are used, no DTX shall be inserted, since the exact room for the gap is already reserved thanks to the earlier insertion of the p-bits.

In frames compressed by higher layer scheduling, additional DTX with respect to normal mode shall be inserted if the transmission time reduction does not exactly create a transmission gap of the desired TGL.

The number of bits available to the CCTrCH in one radio frame compressed by spreading factor reduction or by higher layer scheduling is denoted by $N_{data,*}^{cm}$ and $R = \frac{N_{data,*}^{cm}}{P}$.

For frames compressed by spreading factor reduction $N_{data,*}^{cm} = \frac{N'_{data,*}}{2}$.

For frames compressed by higher layer scheduling the exact value of $N_{data,*}^{cm}$ is dependent on the *TGL* which is signalled from higher layers. It can be calculated as $N_{data,*}^{cm} = N'_{data,*} - N_{TGL}$.

N_{TGL} is the number of bits that are located within the transmission gap and defined as:

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

N_{first} and *TGL* are defined in subclause 4.4.

The bits output from the DTX insertion block are denoted by $w_1, w_2, w_3, \dots, w_{(PR)}$. Note that these bits are four valued in case of compressed mode by puncturing, and three valued otherwise. They are defined by the following relations:

$w_k = s_k$ k = 1, 2, 3, …, S

$w_k = \delta$ k = S+1, S+2, S+3, …, $P \cdot R$

where DTX indication bits are denoted by δ. Here $s_k \in \{0,1, \text{p}\}$ and $\delta \notin \{0,1\}$.

4.2.10 Physical channel segmentation

When more than one PhCH is used, physical channel segmentation divides the bits among the different PhCHs. The bits input to the physical channel segmentation are denoted by $x_1, x_2, x_3, \dots, x_X$, where *X* is the number of bits input to the physical channel segmentation block. The number of PhCHs is denoted by *P*.

The bits after physical channel segmentation are denoted $u_{p1}, u_{p2}, u_{p3}, \dots, u_{pU}$, where *p* is PhCH number and *U* is the number of bits in one radio frame for each PhCH, i.e. $U = (X - N_{TGL} - (N_{data,*} - N'_{data,*})) / P$ for compressed mode by puncturing, and $U = \frac{X}{P}$ otherwise. The relation between x_k and u_{pk} is given below.

For all modes, some bits of the input flow are mapped to each code until the number of bits on the code is *U*. For modes other than compressed mode by puncturing, all bits of the input flow are taken to be mapped to the codes. For compressed mode by puncturing, only the bits of the input flow not corresponding to bits p are taken to be mapped to the codes, each bit p is removed to ensure creation the gap required by the compressed mode, as described below.

Bits on first PhCH after physical channel segmentation:

$u_{1,k} = x_{f(k)}$ $k = 1, 2, \dots, U$

Bits on second PhCH after physical channel segmentation:

$u_{2,k} = x_{f(k+U)}$ $k = 1, 2, \ldots, U$

…

Bits on the P^{th} PhCH after physical channel segmentation:

$u_{P,k} = x_{f(k+(P-1)\times U)}$ $k = 1, 2, \ldots, U$

where *f* is such that :

- for modes other than compressed mode by puncturing, $x_{f(k)} = x_k$, i.e. $f(k) = k$, for all *k*.
- for compressed mode by puncturing, bit $u_{1,1}$ corresponds to the bit x_k with smallest index *k* when the bits p are not counted, bit $u_{1,2}$ corresponds to the bit x_k with second smallest index *k* when the bits p are not counted, and so on for bits $u_{1,3}, \ldots u_{1,U}, u_{2,1}, u_{2,2}, \ldots u_{2,U}, \ldots u_{P,1}, u_{P,2}, \ldots u_{P,U}$.

4.2.10.1 Relation between input and output of the physical segmentation block in uplink

The bits input to the physical segmentation are denoted by $s_1, s_2, s_3, \ldots, s_S$. Hence, $x_k = s_k$ and $Y = S$.

4.2.10.2 Relation between input and output of the physical segmentation block in downlink

The bits input to the physical segmentation are denoted by $w_1, w_2, w_3, \ldots, w_{(PU)}$. Hence, $x_k = w_k$ and $Y = PU$.

Document *R1-00-1277*
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**	**097**	Current Version: 3.4.0

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

For submission to:	RAN#10	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: (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]
(at least one should be marked with an X)

Source: TSG RAN WG1 **Date:** 2000-10

Subject: Clarification on the C_i formula

Work item:

Category:
(only one category Shall be marked With an X)

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

Release:

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

Reason for change:

- The value of $\lceil X_i / Z \rceil$ for $Z = \mathit{unlimited}$ is not so obvious, all the more that $x \mapsto \lceil x \rceil$ is not a continuous function.
- The code block size computation is not applicable when the number of code block is null

Clauses affected: 4.2.2.2

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: This also clarify that the padding up to 40 bits for turbo coding is not applicable for $C_i = 0$.

4.2.2.2 Code block segmentation

Segmentation of the bit sequence from transport block concatenation is performed if $X_i>Z$. The code blocks after segmentation are of the same size. The number of code blocks on TrCH i is denoted by C_i. If the number of bits input to the segmentation, X_i, is not a multiple of C_i, filler bits are added to the beginning of the first block. If turbo coding is selected and $X_i < 40$, filler bits are added to the beginning of the code block. The filler bits are transmitted and they are always set to 0. The maximum code block sizes are:

- convolutional coding: $Z = 504$;
- turbo coding: $Z = 5114$;
- no channel coding: $Z = unlimited$.

The bits output from code block segmentation, for $C_i \neq 0$, are denoted by $o_{ir1}, o_{ir2}, o_{ir3}, \ldots, o_{irK_i}$, where i is the TrCH number, r is the code block number, and K_i is the number of bits per code block.

Number of code blocks:

~~$C_i = \lceil X_i / Z \rceil$~~

$$C_i = \begin{cases} \lceil X_i / Z \rceil & \text{when } Z \neq unlimited \\ 0 & \text{when } Z = unlimited \text{ and } X_i = 0 \\ 1 & \text{when } Z = unlimited \text{ and } X_i \neq 0 \end{cases}$$

Number of bits in each code block (applicable for $C_i \neq 0$ only):

if $X_i < 40$ and Turbo coding is used, then

$K_i = 40$

else

$K_i = \lceil X_i / C_i \rceil$

end if

Number of filler bits: $Y_i = C_iK_i - X_i$

for $k = 1$ to Y_i -- Insertion of filler bits

$o_{i1k} = 0$

end for

for $k = Y_i+1$ to K_i

$o_{i1k} = x_{i,(k-Y_i)}$

end for

$r = 2$ -- Segmentation

while $r \leq C_i$

for $k = 1$ to K_i

$o_{irk} = x_{i,(k+(r-1)\cdot K_i - Y_i)}$

end for

$r = r+1$

end while

end if

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Bangkok, Thailand, 6-8, December 2000

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

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25.212 CR 099 Current Version: 3.4.0

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

For submission to: TSG-RAN #10
list expected approval meeting # here ↑

for approval	X	strategic		*(for SMG use only)*
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: (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]
(at least one should be marked with an X)

Source: TSG RAN WG1 **Date:** 21/11/2000

Subject: Editorial modification in RM section.

Work item: AH99

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:

- In figure 2, bits w_1, w_2, …, w_R were numbered up to p,R. But index p on PhCH is inconsistent as physical channel segmentation is not yet done for these bits.
- In section 4.2.7.2.2 and subsection thereof the multiply sign does not always follow the agreed notational conventions ×
- In section 4.2.7.2.2.1, TFC l was replaced by TFC j in a comment to be in line with the notation for TFC index.

Clauses affected: 4.2, 4.2.7.2.2, 4.2.7.2.2.1, 4.2.7.2.2.2, 4.2.7.2.2.3

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: None

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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 subclause 4.2.1);
- transport block concatenation and code block segmentation (see subclause 4.2.2);
- channel coding (see subclause 4.2.3);
- radio frame equalisation (see subclause 4.2.4);
- rate matching (see subclause 4.2.7);
- insertion of discontinuous transmission (DTX) indication bits (see subclause 4.2.9);
- interleaving (two steps, see subclauses 4.2.5 and 4.2.11);
- radio frame segmentation (see subclause 4.2.6);
- multiplexing of transport channels (see subclause 4.2.8);
- physical channel segmentation (see subclause 4.2.10);
- mapping to physical channels (see subclause 4.2.12).

The coding/multiplexing steps for uplink and downlink are shown in figure 1 and figure 2 respectively.

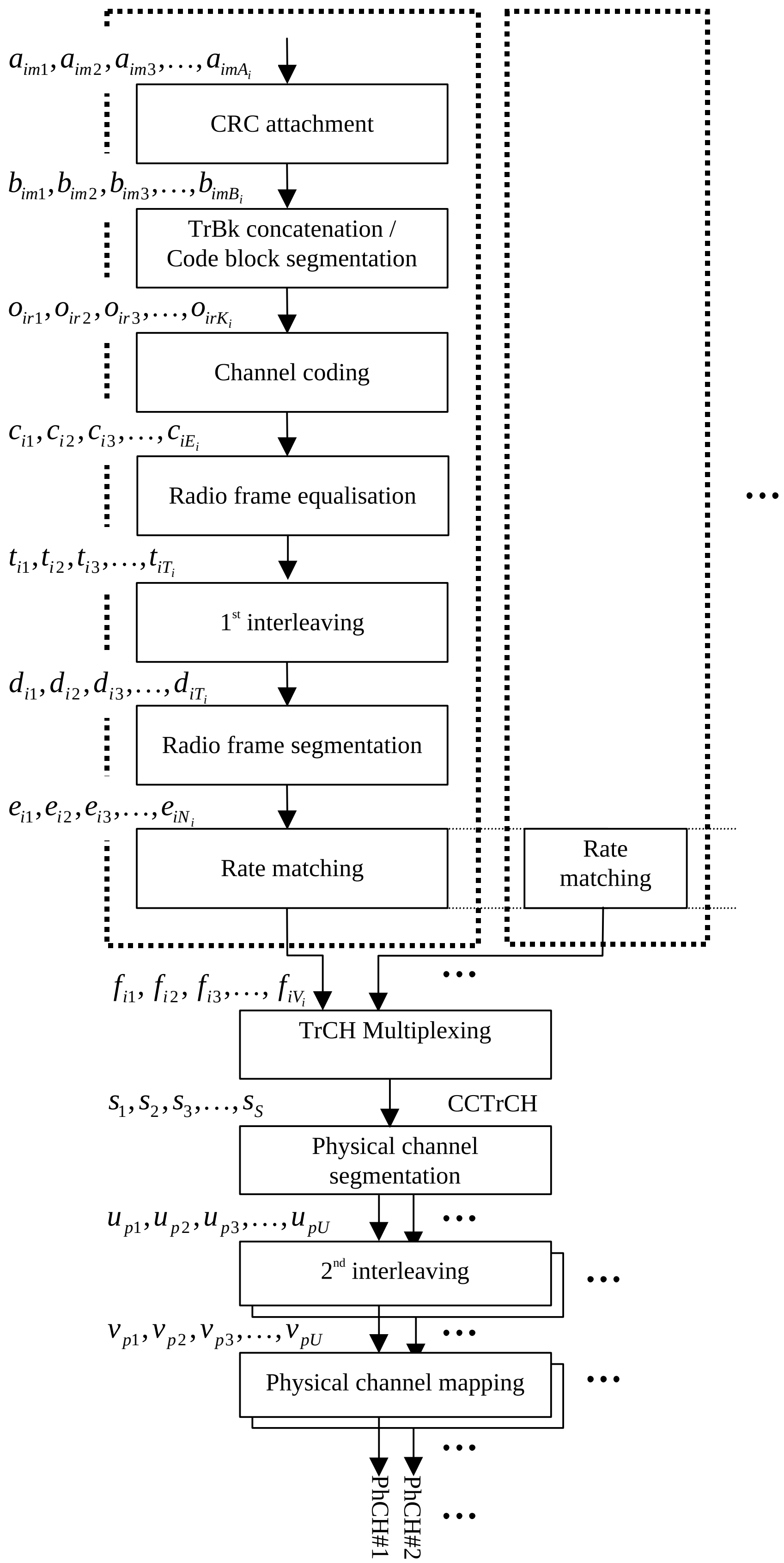
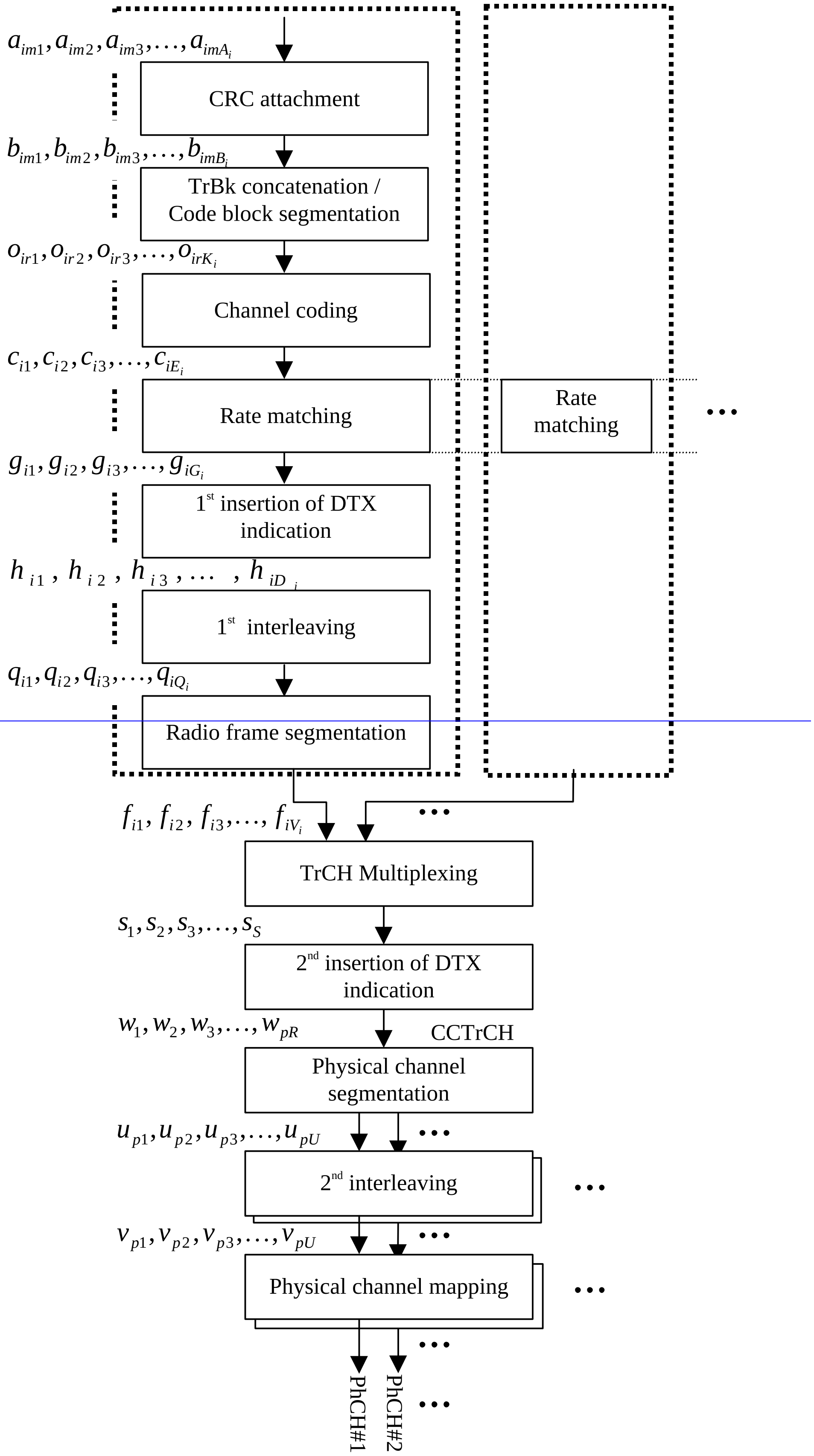


Figure 1: Transport channel multiplexing structure for uplink


$a_{im1}, a_{im2}, a_{im3}, \ldots, a_{imA_i}$
CRC attachment
$b_{im1}, b_{im2}, b_{im3}, \ldots, b_{imB_i}$
TrBk concatenation / Code block segmentation
$o_{ir1}, o_{ir2}, o_{ir3}, \ldots, o_{irK_i}$
Channel coding
$c_{i1}, c_{i2}, c_{i3}, \ldots, c_{iE_i}$
Rate matching
Rate matching
$g_{i1}, g_{i2}, g_{i3}, \ldots, g_{iG_i}$
1st insertion of DTX indication
$h_{i1}, h_{i2}, h_{i3}, \ldots, h_{iD_i}$
1st interleaving
$q_{i1}, q_{i2}, q_{i3}, \ldots, q_{iQ_i}$
Radio frame segmentation
$f_{i1}, f_{i2}, f_{i3}, \ldots, f_{iV_i}$
TrCH Multiplexing
$s_1, s_2, s_3, \ldots, s_S$
2nd insertion of DTX indication
$w_1, w_2, w_3, \ldots, w_{pR}$
CCTrCH
Physical channel segmentation
$u_{p1}, u_{p2}, u_{p3}, \ldots, u_{pU}$
2nd interleaving
$v_{p1}, v_{p2}, v_{p3}, \ldots, v_{pU}$
Physical channel mapping
PhCH#1
PhCH#2

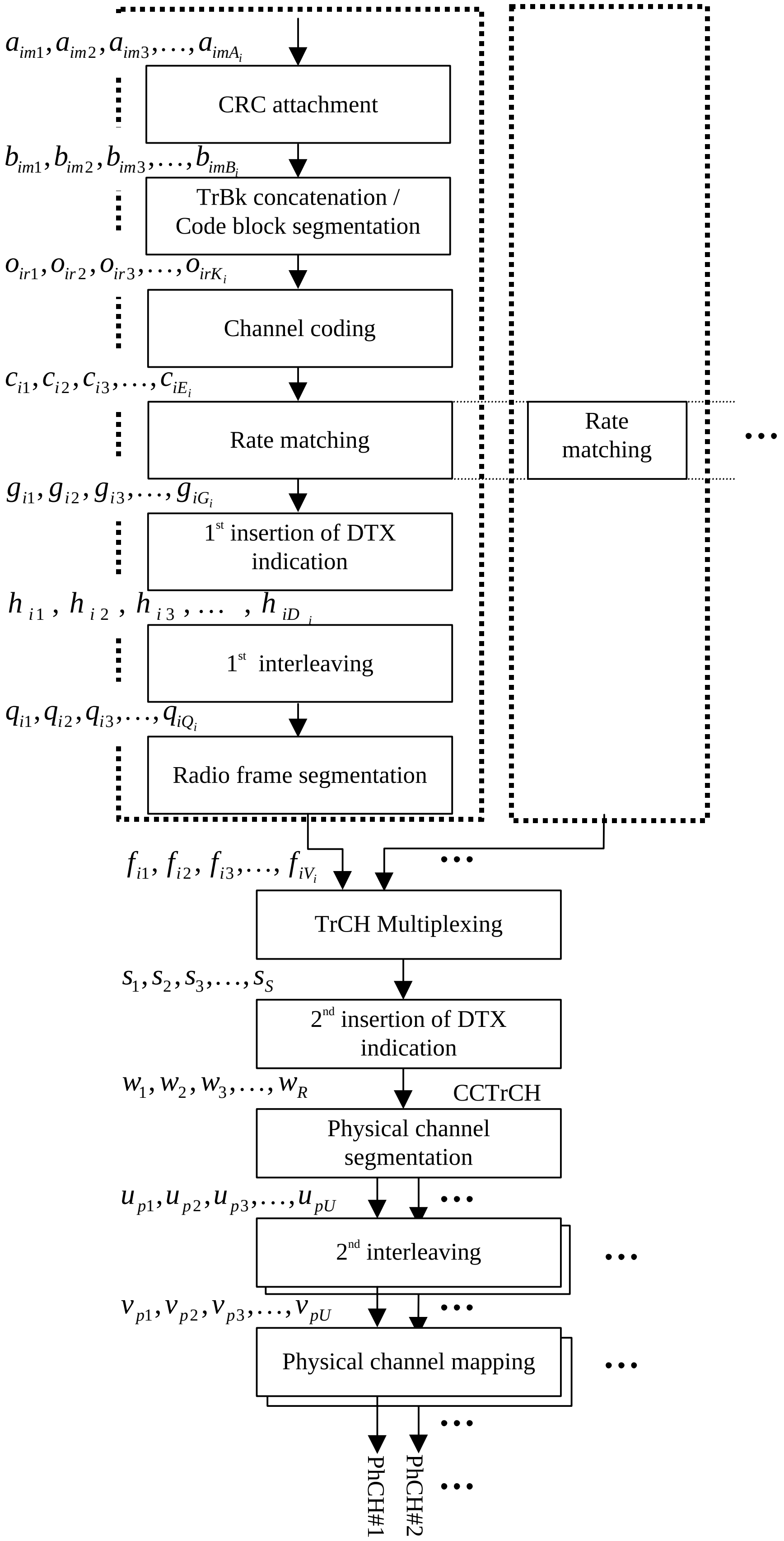


Figure 2: Transport channel multiplexing structure for downlink

The single output data stream from the TrCH multiplexing, including DTX indication bits in downlink, is denoted *Coded Composite Transport Channel (CCTrCH)*. A CCTrCH can be mapped to one or several physical channels.

4.2.7.2.2 Determination of rate matching parameters for flexible positions of TrCHs

4.2.7.2.2.1 Calculations for normal mode, compressed mode by higher layer scheduling, and compressed mode by spreading factor reduction

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

$$\cancel{N_{i,j} = \frac{1}{F_i}\cdot N^{TTI}_{i,TF_i(j)}}\quad N_{i,j} = \frac{1}{F_i}\times N^{TTI}_{i,TF_i(j)}$$

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:

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

The computation of $\Delta N^{TTI}_{i,l}$ parameters is then performed in two phases. In a first phase, tentative temporary values of $\Delta N^{TTI}_{i,l}$ 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 $\Delta N^{TTI}_{i,l}$ is the definitive value.

The first phase defines the tentative temporary $\Delta N^{TTI}_{i,l}$ for all transport channel *i* and any of its transport format *l* by use of the following formula:

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

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

The second phase is defined by the following algorithm:

for all j in *TFCS* in ascending order of TFCI do -- for all TFC

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

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

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

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

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

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

end-if

end-for

end-if

end-for

If $\Delta N^{TTI}_{i,l} = 0$ 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 subclause 4.2.7.5 does not need to be executed.

If $\Delta N^{TTI}_{i,l} \neq 0$ the parameters listed in subclauses 4.2.7.2.2.2 and 4.2.7.2.2.3 shall be used for determining e_{ini}, e_{plus}, and e_{minus}.

4.2.7.2.2.2 Determination of rate matching parameters for uncoded and convolutionally encoded TrCHs

$$\Delta N_i = \Delta N^{TTI}_{il}$$

a=2

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

$$X_i = N^{TTI}_{il}$$

$$e_{ini} = 1$$

$$\cancel{e_{plus} = a \cdot N^{TTI}_{il}}\ \underline{e_{plus} = a \times N^{TTI}_{il}}$$

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

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

4.2.7.2.2.3 Determination of rate matching parameters for Turbo encoded TrCHs

If repetition is to be performed on turbo encoded TrCHs, i.e. $\Delta N^{TTI}_{il} > 0$, the parameters in subclause 4.2.7.2.2.2 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.

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

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

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

$$e_{ini} = X_i,$$

$$\cancel{e_{plus} = a \cdot X_i}\; e_{plus} = a \times X_i$$

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

3GPP TSG RAN Meeting #10
Bangkok, Thailand, 6-8, December 2000

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25.212	**CR**	**100r1**	Current Version:	3.4.0

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

For submission to:	RAN #10	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: (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]
(at least one should be marked with an X)

Source:	TSG RAN WG1	**Date:**	21-Nov.-2000
Subject:	Editorial corrections in TS 25.212		
Work item:			

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

Reason for change: To correct wording in CRC attachment, 1st interleaving and 2nd interleaving sections.
To clarify bits padding and pruning for rectangular matrix of 2nd interleaving.
To align mathematical notations with preferred notations shown in TS 25.201 Annex A.

Clauses affected: 3.3, 4.2.1, 4.2.1.1, 4.2.1.1.1, 4.2.5.2 and 4.2.11 of TS 25.212

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:

TrCH number: Transport channel number represents a TrCH ID assigned to L1 by L2. Transport channels are multiplexed to the CCTrCH in the ascending order of these IDs.

3.2 Symbols

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

$\lceil x \rceil$	round towards ∞, i.e. integer such that $x \le \lceil x \rceil < x+1$
$\lfloor x \rfloor$	round towards $-\infty$, i.e. integer such that $x-1 < \lfloor x \rfloor \le x$
$\lvert x \rvert$	absolute value of x
sgn(x)	signum function, i.e. $\operatorname{sgn}(x) = \begin{cases} 1; & x \ge 0 \\ -1; & x < 0 \end{cases}$
N_{first}	The first slot in the *TG*, located in the first compressed radio frame if the TG spans two frames.
N_{last}	The last slot in the *TG*, located in the second compressed radio frame if the TG spans two frames.
N_{tr}	Number of transmitted slots in a radio frame.

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.
$N_{data,j}$	Number of data bits that are available for the CCTrCH in a radio frame with TFC j.
$N_{data,j}^{cm}$	Number of data bits that are available for the CCTrCH in a compressed radio frame with TFC j.
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.

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

x, X
y, Y
z, Z

3.3 Abbreviations

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

ARQ	Automatic Repeat Request
BCH	Broadcast Channel
BER	Bit Error Rate
BLER	Block Error Rate
BS	Base Station
CCPCH	Common Control Physical Channel
CCTrCH	Coded Composite Transport Channel
CFN	Connection Frame Number
CRC	Cyclic Redundancy Check~~Code~~
DCH	Dedicated Channel
DL	Downlink (Forward link)
DPCCH	Dedicated Physical Control Channel
DPCH	Dedicated Physical Channel

DPDCH	Dedicated Physical Data Channel
DS-CDMA	Direct-Sequence Code Division Multiple Access
DSCH	Downlink Shared Channel
DTX	Discontinuous Transmission
FACH	Forward Access Channel
FDD	Frequency Division Duplex
FER	Frame Error Rate
GF	Galois Field
MAC	Medium Access Control
Mcps	Mega Chip Per Second
MS	Mobile Station
OVSF	Orthogonal Variable Spreading Factor (codes)
PCCC	Parallel Concatenated Convolutional Code
PCH	Paging Channel
PhCH	Physical Channel
PRACH	Physical Random Access Channel
RACH	Random Access Channel
RSC	Recursive Systematic Convolutional Coder
RX	Receive
SCH	Synchronisation Channel
SF	Spreading Factor
SFN	System Frame Number
SIR	Signal-to-Interference Ratio
SNR	Signal to Noise Ratio
TF	Transport Format
TFC	Transport Format Combination
TFCI	Transport Format Combination Indicator
TPC	Transmit Power Control
TrCH	Transport Channel
TTI	Transmission Time Interval
TX	Transmit
UL	Uplink (Reverse link)

4.2.1 CRC attachment~~Error detection~~

Error detection is provided on transport blocks through a Cyclic Redundancy Check (CRC). The size of the CRC is 24, 16, 12, 8 or 0 bits and it is signalled from higher layers what CRC ~~length~~size that should be used for each TrCH.

4.2.1.1 CRC Calculation

The entire transport block is used to calculate the CRC parity bits for each transport block. The parity bits are generated by one of the following cyclic generator polynomials:

- g_{CRC24}(~~D~~D) = ~~D~~D^{24} + ~~D~~D^{23} + ~~D~~D^{6} + ~~D~~D^{5} + ~~D~~D + 1;
- g_{CRC16}(~~D~~D) = ~~D~~D^{16} + ~~D~~D^{12} + ~~D~~D^{5} + 1;
- g_{CRC12}(~~D~~D) = ~~D~~D^{12} + ~~D~~D^{11} + ~~D~~D^{3} + ~~D~~D^{2} + ~~D~~D + 1;
- g_{CRC8}(~~D~~D) = ~~D~~$D^{\cancel{8}8}$ + ~~D~~D^{7} + ~~D~~D^{4} + ~~D~~D^{3} + ~~D~~D + 1.

Denote the bits in a transport block delivered to layer 1 by $a_{im1}, a_{im2}, a_{im3}, \ldots, a_{imA_i}$, and the parity bits by $p_{im1}, p_{im2}, p_{im3}, \ldots, p_{imL_i}$. A_i is the ~~length~~size of a transport block of TrCH i, m is the transport block number, and ~~L_i~~L_i is the number of parity bits. L_i can take the values 24, 16, 12, 8, or 0 depending on what is signalled from higher layers.

The encoding is performed in a systematic form, which means that in GF(2), the polynomial:

$$a_{im1}D^{A_i+23} + a_{im2}D^{A_i+22} + \ldots + a_{imA_i}D^{24} + p_{im1}D^{23} + p_{im2}D^{22} + \ldots + p_{im23}D^{1} + p_{im24}$$

yields a remainder equal to 0 when divided by g_{CRC24}(~~D~~D), polynomial:

$$a_{im1}D^{A_i+15} + a_{im2}D^{A_i+14} + \ldots + a_{imA_i}D^{16} + p_{im1}D^{15} + p_{im2}D^{14} + \ldots + p_{im15}D^{1} + p_{im16}$$

yields a remainder equal to 0 when divided by g_{CRC16}(~~D~~D), polynomial:

$$a_{im1}D^{A_i+11} + a_{im2}D^{A_i+10} + \ldots + a_{imA_i}D^{12} + p_{im1}D^{11} + p_{im2}D^{10} + \ldots + p_{im11}D^{1} + p_{im12}$$

yields a remainder equal to 0 when divided by g_{CRC12}(~~D~~D) and polynomial:

$$a_{im1}D^{A_i+7} + a_{im2}D^{A_i+6} + \ldots + a_{imA_i}D^{8} + p_{im1}D^{7} + p_{im2}D^{6} + \ldots + p_{im7}D^{1} + p_{im8}$$

yields a remainder equal to 0 when divided by g_{CRC8}(~~D~~D).

If no transport blocks are input to the CRC calculation ($M_i = 0$), no CRC attachment shall be done. If transport blocks are input to the CRC calculation ($M_i \neq 0$) and the size of a transport block is zero ($A_i = 0$), CRC shall be attached, i.e. all parity bits equal to zero.

4.2.1.2~~4.2.1.1.1~~ Relation between input and output of the CRC attachment block~~Cyclic Redundancy Check~~

The bits after CRC attachment are denoted by $b_{im1}, b_{im2}, b_{im3}, \ldots, b_{imB_i}$, where $B_i = A_i + L_i$. The relation between a_{imk} and b_{imk} is:

$$b_{imk} = a_{imk} \qquad k = 1, 2, 3, \ldots, A_i$$

$$b_{imk} = p_{im(L_i+1-(k-A_i))} \qquad k = A_i + 1, A_i + 2, A_i + 3, \ldots, A_i + L_i$$

$Np_{i,\max}^{TTI,m}$ is defined in the Rate Matching subclause 4.2.7.

$P1_{Fi}(x)$ defines the inter column permutation function for a TTI of length $F_i \times 10$ms, as defined in Table 3 in section 4.2.5.2. $P1_{Fi}(x)$ is the Bit Reversal function of x on $\log_2(F_i)$ bits.

NOTE 1: C[x], x= 0 to F_i– 1, the number of bits p which have to be inserted in each of the F_i segments of the TTI, where x is the column number before permutation, i.e. in each column of the first interleaver. $C[P1_{Fi}(x)]$ is equal to $Np_{i,\max}^{m\times F_i+x}$ for x equal 0 to F_i–1 for fixed positions. It is noted $Np_i^{m\times F_i+x}$ in the following initialisation step.

NOTE 2: cbi[x], x=0 to F_i – 1, the counter of the number of bits p inserted in each of the F_i segments of the TTI, i.e. in each column of the first interleaver x is the column number before permutation.

col = 0

while col < F_i **do** -- here col is the column number after column permutation

$C[P1_{Fi}(col)] = Np_i^{m\times F_i+col}$ -- initialisation of number of bits p to be inserted in each of the F_i segments of the TTI number *m*

$cbi[P1_{Fi}(col)] = 0$ -- initialisation of counter of number of bits p inserted in each of the F_i segments of the TTI

col = col +1

end do

n = 0, m = 0

while n < X_i **do** -- from here col is the column number before column permutation

col = *n* mod F_i

if cbi[col] < C[col] **do**

$x_{i,n}$ = p -- insert one p bit

cbi[col] = cbi[col]+1 -- update counter of number of bits p inserted

else -- no more p bit to insert in this segment

$x_{i,n} = z_{i,,m}$

m = m+1

endif

n = n +1

end do

4.2.5.2 1st interleaver operation

The 1st interleaving is a block interleaver with inter-column permutations. The input bit sequence to the ~~1st~~ block interleaver is denoted by $x_{i,1}, x_{i,2}, x_{i,3}, \ldots, x_{i,X_i}$, where *i* is TrCH number and X_i the number of bits. ~~(at this stage~~ Here X_i is ~~assumed and~~ guaranteed to be an integer multiple of the number of radio frames in the TTI~~)~~. The output bit sequence from the block interleaver is derived as follows:

(1) Select the number of columns C1 from table 4 depending on the TTI. The columns are numbered 0, 1, …, C1 - 1 from left to right.

(2) Determine the number of rows of the matrix, R1 defined as~~:~~

$R1 = X_i / C1$.

The rows of the matrix are numbered 0, 1, …, R1 - 1 from top to bottom.

(3) Write the input bit sequence into the R1 × C1 ~~rectangular~~ matrix row by row starting with bit $x_{i,1}$ in ~~the first~~ column 0 of ~~the first~~ row 0 and ending with bit $x_{i,(R1\times C1)}$ in column C1 - 1 of row R1 - 1:

$$\begin{bmatrix} x_{i,1} & x_{i,2} & x_{i,3} & \dots & x_{i,C1} \\ x_{i,(C1+1)} & x_{i,(C1+2)} & x_{i,(C1+3)} & \dots & x_{i,(2\times C1)} \\ \vdots & \vdots & \vdots & \dots & \vdots \\ x_{i,((R1-1)\times C1+1)} & x_{i,((R1-1)\times C1+2)} & x_{i,((R1-1)\times C1+3)} & \dots & x_{i,(R1\times C1)} \end{bmatrix}$$

(4) Perform the inter-column permutation for the matrix based on the pattern $\langle P1_{C1}(j) \rangle_{j\in\{0,1,\dots,C1-1\}}$ shown in table 4, where $P1_{C1}(j)$ is the original column position of the j-th permuted column. After permutation of the columns, the bits are denoted by y_{ik}:

$$\begin{bmatrix} y_{i,1} & y_{i,(R1+1)} & y_{i,(2\times R1+1)} & \dots & y_{i,((C1-1)\times R1+1)} \\ y_{i,2} & y_{i,(R1+2)} & y_{i,(2\times R1+2)} & \dots & y_{i,((C1-1)\times R1+2)} \\ \vdots & \vdots & \vdots & \dots & \vdots \\ y_{i,R1} & y_{i,(2\times R1)} & y_{i,(3\times R1)} & \dots & y_{i,(C1\times R1)} \end{bmatrix}$$

(5) Read the output bit sequence $\cancel{y_{i1}, y_{i2}, y_{i3}, \dots, y_{i,(C1\times R1)}}$ $y_{i,1}, y_{i,2}, y_{i,3}, \dots, y_{i,(C1\times R1)}$ of the ~~1st~~ block interleav~~ing~~ering column by column from the inter-column permuted R1 × C1 matrix. Bit $y_{i,1}$ corresponds to ~~the first~~ row 0 of ~~the first~~ column 0 and bit $y_{i,(R1\times C1)}$ corresponds to row R1 - 1 of column C1 - 1.

Table 4 Inter-column permutation patterns for 1st interleaving

TTI	Number of columns C1	Inter-column permutation patterns <$P1_{C1}(0)$, $P1_{C1}(1)$, …, $P1_{C1}(C1-1)$>
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>

Bits on second PhCH after physical channel segmentation:

$u_{2,k} = x_{f(k+U)}$ $k = 1, 2, \ldots, U$

…

Bits on the P^{th} PhCH after physical channel segmentation:

$u_{P,k} = x_{f(k+(P-1)\times U)}$ $k = 1, 2, \ldots, U$

where f is such that :

- for modes other than compressed mode by puncturing, $x_{f(k)} = x_k$, i.e. $f(k) = k$, for all k.
- for compressed mode by puncturing, bit $u_{1,1}$ corresponds to the bit x_k with smallest index k when the bits p are not counted, bit $u_{1,2}$ corresponds to the bit x_k with second smallest index k when the bits p are not counted, and so on for bits $u_{1,3}, \ldots u_{1,U}, u_{2,1}, u_{2,2}, \ldots u_{2,U}, \ldots u_{P,1}, u_{P,2}, \ldots u_{P,U}$.

4.2.10.1 Relation between input and output of the physical segmentation block in uplink

The bits input to the physical segmentation are denoted by $s_1, s_2, s_3, \ldots, s_S$. Hence, $x_k = s_k$ and $Y = S$.

4.2.10.2 Relation between input and output of the physical segmentation block in downlink

The bits input to the physical segmentation are denoted by $w_1, w_2, w_3, \ldots, w_{(PU)}$. Hence, $x_k = w_k$ and $Y = PU$.

4.2.11 2nd interleaving

The 2nd interleaving is a block interleaver and consists of bits input to a matrix with padding, ~~with~~the inter-column permutations for the matrix and bits output from the matrix with pruning. The bits input to the 2nd block interleaver are denoted by $u_{p,1}, u_{p,2}, u_{p,3}, \ldots, u_{p,U}$, where p is PhCH number and U is the number of bits in one radio frame for one PhCH. The output bit sequence from the block interleaver is derived as follows:

(1) ~~Set the number of columns~~Assign C2 = 30 to be the number of columns of the matrix. The columns of the matrix are numbered 0, 1, 2, …, C2 - 1 from left to right.

(2) Determine the number of rows of the matrix, R2, by finding minimum integer R2 such that:

$U \leq \text{R2} \times \text{C2}$.

The rows of rectangular matrix are numbered 0, 1, 2, …, R2 - 1 from top to bottom.

(3) Write ~~T~~the ~~bits~~ input bit sequence $u_{p,1}, u_{p,2}, u_{p,3}, \ldots, u_{p,U}$ ~~to the 2nd interleaving are written~~ into the R2 × C2 ~~rectangular~~ matrix row by row~~.~~ starting with bit $y_{p,1}$ in column 0 of row 0:

$$\begin{bmatrix} u_{p,1} & u_{p,2} & u_{p,3} & \cdots & u_{p,30} \\ u_{p,31} & u_{p,32} & u_{p,33} & \cdots & u_{p,60} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ u_{p,((R2-1)\times 30+1)} & u_{p,((R2-1)\times 30+2)} & u_{p,((R2-1)\times 30+3)} & \cdots & u_{p,(R2\times 30)} \end{bmatrix}$$

$$\begin{bmatrix} y_{p,1} & y_{p,2} & y_{p,3} & \cdots & y_{p,C2} \\ y_{p,(C2+1)} & y_{p,(C2+2)} & y_{p,(C2+3)} & \cdots & y_{p,(2\times C2)} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ y_{p,((R2-1)\times C2+1)} & y_{p,((R2-1)\times C2+2)} & y_{p,((R2-1)\times C2+3)} & \cdots & y_{p,(R2\times C2)} \end{bmatrix}$$

where $y_{p,k} = u_{p,k}$ for k = 1, 2, …, U and if R2 × C2 > U, the dummy bits are padded such that $y_{p,k}$ = 0 or 1 for k = U + 1, U + 2, …, R2 × C2. These dummy bits are pruned away from the output of the matrix after the inter-column permutation.

(4) Perform the inter-column permutation for the matrix based on the pattern ~~P2(j) (j = 0, 1, ..., C2-1)~~ $\langle \mathrm{P2}(j) \rangle_{j \in \{0,1,\ldots,\mathrm{C2}-1\}}$ that is shown in table 7, where P2(j) is the original column position of the j-th permuted column. After permutation of the columns, the bits are denoted by ~~y_{pk}~~ $y'_{p,k}$.

$$\begin{bmatrix} y_{p,1} & y_{p,(\mathrm{R2}+1)} & y_{p,(2\times\mathrm{R2}+1)} & \cdots y_{p,(29\times\mathrm{R2}+1)} \\ y_{p,2} & y_{p,(\mathrm{R2}+2)} & y_{p,(2\times\mathrm{R2}+2)} & \cdots y_{p,(29\times\mathrm{R2}+2)} \\ \vdots & \vdots & \vdots & \cdots \quad \vdots \\ y_{p,\mathrm{R2}} & y_{p,(2\times\mathrm{R2})} & y_{p,(3\times\mathrm{R2})} & \cdots \; y_{p,(30\times\mathrm{R2})} \end{bmatrix} \begin{bmatrix} y'_{p,1} & y'_{p,(\mathrm{R2}+1)} & y'_{p,(2\times\mathrm{R2}+1)} & \cdots y'_{p,((\mathrm{C2}-1)\times\mathrm{R2}+1)} \\ y'_{p,2} & y'_{p,(\mathrm{R2}+2)} & y'_{p,(2\times\mathrm{R2}+2)} & \cdots y'_{p,((\mathrm{C2}-1)\times\mathrm{R2}+2)} \\ \vdots & \vdots & \vdots & \cdots \quad \vdots \\ y'_{p,\mathrm{R2}} & y'_{p,(2\times\mathrm{R2})} & y'_{p,(3\times\mathrm{R2})} & \cdots \; y'_{p,(\mathrm{C2}\times\mathrm{R2})} \end{bmatrix}$$

(5) The output of the ~~2nd~~ block interleaver~~ing~~ is the bit sequence read out column by column from the inter-column permuted R2 × C2 matrix. The output is pruned by deleting dummy bits that were ~~not present~~padded ~~in~~to the input ~~bit sequence~~of the matrix before the inter-column permutation, i.e. bits ~~y_{pk}~~ $y'_{p,k}$ that corresponds to bits ~~u_{pk}~~ $y_{p,k}$ with k>U are removed from the output. The bits after 2nd interleaving are denoted by $v_{p,1}, v_{p,2}, \ldots, v_{p,U}$, where $v_{p,1}$ corresponds to the bit ~~$y_{p,k}$~~ $y'_{p,k}$ with smallest index k after pruning, $v_{p,2}$ to the bit ~~$y_{p,k}$~~ $y'_{p,k}$ with second smallest index k after pruning, and so on.

Table 7 Inter-column permutation pattern for 2nd interleaving

Number of columns C2	Inter-column permutation pattern < P2(0), P2(1), …, P2(~~29~~C2-1) >
30	<0, 20, 10, 5, 15, 25, 3, 13, 23, 8, 18, 28, 1, 11, 21, 6, 16, 26, 4, 14, 24, 19, 9, 29, 12, 2, 7, 22, 27, 17>

3GPP TSG RAN Meeting #10
Bangkok, Thailand, 6-8, December 2000

Document R1-00-1446
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**	**101**	Current Version:	3.4.0	

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

For submission to:	RAN#10	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:	TSG RAN WG1	**Date:**	21-Nov-2000
Subject:	Correction to code block segmentation		
Work item:	Release 99		

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

Reason for change:	Useless "end if" in the code block segmentation algorithm
Clauses affected:	4.2.2.2

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.

4.2.2.2 Code block segmentation

Segmentation of the bit sequence from transport block concatenation is performed if $X_i>Z$. The code blocks after segmentation are of the same size. The number of code blocks on TrCH i is denoted by C_i. If the number of bits input to the segmentation, X_i, is not a multiple of C_i, filler bits are added to the beginning of the first block. If turbo coding is selected and X_i < 40, filler bits are added to the beginning of the code block. The filler bits are transmitted and they are always set to 0. The maximum code block sizes are:

- convolutional coding: Z = 504;
- turbo coding: Z = 5114;
- no channel coding: Z = *unlimited*.

The bits output from code block segmentation are denoted by $o_{ir1}, o_{ir2}, o_{ir3}, \ldots, o_{irK_i}$, where i is the TrCH number, r is the code block number, and K_i is the number of bits.

Number of code blocks: $C_i = \lceil X_i / Z \rceil$

Number of bits in each code block:

if X_i < 40 and Turbo coding is used, then

K_i = 40

else

$K_i = \lceil X_i / C_i \rceil$

end if

Number of filler bits: $Y_i = C_iK_i - X_i$

for k = 1 to Y_i -- Insertion of filler bits

$o_{i1k} = 0$

end for

for $k = Y_i$+1 to K_i

$o_{i1k} = x_{i,(k-Y_i)}$

end for

r = 2 -- Segmentation

while $r \le C_i$

for k = 1 to K_i

$o_{irk} = x_{i,(k+(r-1)\cdot K_i - Y_i)}$

end for

$r = r$+1

end while

~~end if~~