TSG-RAN Working Group 1 meeting #9
Dresden, Germany
November 30 – December 3, 1999

TSGR1#9(99)l27

Agenda item:

Source: Ericsson

Title: CR 25.212-012r2: Zero length transport blocks

Document for: Decision

The coding and multiplexing needs to handle transport block numbers of zero, i.e. the case when no transport blocks arrive for transmission in the TTI. Efficient handling of zero transport blocks is important, but exactly how to handle them is not clearly specified in all parts of TS 25.212.

Another scenario can be a whole CCTrCH that has zero transport blocks on all TrCHs. Also this case needs to be handled.

Clearly, one do not want to send any bits at all when there is no data to be transmitted, i.e. no CRC shall be attached, no tail bits shall be added, no coding shall be performed, etc.

The impact on the downlink and uplink functions for the cases with zero length transport blocks is listed below.

Downlink:

- **CRC attachment**: If no transport blocks are available ($M_i = 0$), the function shall be transparent.
- **TrBk concatenation/code block segmentation**: The function can handle the case of no input bits.
- **Channel coding**: If no code blocks are available ($C_i = 0$), the function shall be transparent ($E_i = 0$).
- **Rate matching**: The function can handle the case of TrCHs having zero length transport blocks as long as not all TrCHs within the CCTrCH have zero length. If no input bits are available from all TrCHs within the CCTrCH, the function shall be transparent
- **Insertion of DTX indication with fixed positions**: The function can handle the case of no input bits.
- **1st interleaving**: The function can handle the case of no input bits which is possible for flexible positions.
- **Radio frame segmentation**: The function can handle the case of no input bits which is possible for flexible positions.
- **TrCH multiplexing**: The function can handle the special case for all TrCHs within a CCTrCH having zero bits which is possible for flexible positions.
- **Insertion of DTX indication with flexible positions**: The function can handle the case of no input bits.
- **Physical channel segmentation**: No impact since there will always be at least DTX indication bits.
- **2nd interleaving**: No impact since there will always be at least DTX indication bits.
- **Physical channel mapping**: The function can handle the case of CCTrCHs containing only DTX indication bits.

Uplink:

- **CRC**: If no transport blocks are available ($M_i = 0$), the function shall be transparent.

- **TrBk concatenation/code block segmentation**: The function can handle the case of no input bits.
- **Channel coding**: If no code blocks are available (C_i = 0), the function shall be transparent (E_i = 0).
- **Radio frame size equalisation**: The function can handle the special case of no input bits.
- **1st interleaving**: The function can handle the special case of no input bits.
- **Radio frame segmentation**: The function can handle the special case of no input bits.
- **Rate matching**: The function can handle the case of TrCHs having zero length transport blocks as long as not all TrCHs within the CCTrCH have zero length. If no input bits are available from all TrCHs within the CCTrCH, the function shall be transparent and no uplink DPDCH shall be selected.
- **TrCH multiplexing**: The function can handle the special case of all TrCHs within a CCTrCH having zero length.
- **Physical channel segmentation**: The function can handle the special case of all TrCHs within a CCTrCH having zero length.
- **2nd interleaving**: The function can handle the special case of all TrCHs within a CCTrCH having zero length.
- **Physical channel mapping**: The function can handle the special case of all TrCHs within a CCTrCH having zero length, i.e. no uplink physical channel is selected in this case.

From the above list, it can be noted that some additional information is needed in 25.212 to handle the special cases with zero length transport blocks.

It is proposed to include the case of zero length transport blocks into the descriptions of CRC attachment (4.2.1.1), channel coding (4.2.3) and rate matching (4.2.7).

Changes from CR 25.212-012 (R1-99i56):

1. Section 4.2.1.1 (CRC Calculation): "If no transport blocks are input to the CRC calculation (M_i = 0), no CRC attachment shall be done."
2. Section 4.2.3 (Channel coding): "If no code blocks are input to the channel coding (C_i = 0), no bits shall be output from the channel coding, i.e. E_i = 0."
3. Section 4.2.7 (Rate Matching): "…and no uplink DPDCH will be selected in the case of uplink rate matching."

3GPP TSG RAN WG1 Meeting #9
Dresden, Germany, Nov 30 – Dec 3, 1999

Document ??99???
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 012r2 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: TSG-RAN #6
list expected approval meeting # here ↑

for approval	X	b		*(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: Ericsson **Date:** 1999-12-02

Subject: Zero length transport blocks

Work item:

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

F	Correction	X	**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			Release 99	X
				Release 00	

Reason for change: The handling of zero length transport blocks is not described in all parts of the current version of TS 25.212.

Clauses affected: 4.2.1.1, 4.2.3, 4.2.7

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:

help.doc

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

4.2.1 Error detection

Error detection is provided on transport blocks through a Cyclic Redundancy Check. The CRC is 24, 16, 12, 8 or 0 bits and it is signalled from higher layers what CRC length 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:

$g_{CRC24}(D) = D^{24} + D^{23} + D^6 + D^5 + D + 1$

$g_{CRC16}(D) = D^{16} + D^{12} + D^5 + 1$

$g_{CRC12}(D) = D^{12} + D^{11} + D^3 + D^2 + D + 1$

$g_{CRC8}(D) = D^8 + D^7 + D^4 + D^3 + D + 1$

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 of a transport block of TrCH i, m is the transport block number, and L_i is 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 $g_{CRC24}(D)$, 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 $g_{CRC16}(D)$, 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 $g_{CRC12}(D)$ 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 $g_{CRC8}(D)$.

If no transport blocks are input to the CRC calculation ($M_i = 0$), no CRC attachment shall be done.

4.2.1.1.1 Relation between input and output of the 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:

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

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

blocks on TrCH i is denoted by M_i. The bits after concatenation are denoted by $x_{i1}, x_{i2}, x_{i3}, \dots, x_{iX_i}$, where i is the TrCH number and $X_i = M_i B_i$. They are defined by the following relations:

$x_{ik} = b_{i1k}$ k = 1, 2, …, B_i

$x_{ik} = b_{i,2,(k-B_i)}$ $k = B_i + 1, B_i + 2, \dots, 2B_i$

$x_{ik} = b_{i,3,(k-2B_i)}$ $k = 2B_i + 1, 2B_i + 2, \dots, 3B_i$

…

$x_{ik} = b_{i,M_i,(k-(M_i-1)B_i)}$ $k = (M_i - 1)B_i + 1, (M_i - 1)B_i + 2, \dots, M_i B_i$

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 last 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 $o_{ir1}, o_{ir2}, o_{ir3}, \dots, o_{irK_i}$, 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: $K_i = \lceil X_i / C_i \rceil$

Number of filler bits: $Y_i = C_i K_i - X_i$

If $X_i \le Z$, then $o_{i1k} = x_{ik}$, and $K_i = X_i$.

If $X_i \ge Z$, then

$o_{i1k} = x_{ik}$ k = 1, 2, …, K_i

$o_{i2k} = x_{i,(k+K_i)}$ k = 1, 2, …, K_i

$o_{i3k} = x_{i,(k+2K_i)}$ k = 1, 2, …, K_i

…

$o_{iC_ik} = x_{i(k+(C_i-1)K_i)}$ $k = 1, 2, \dots, K_i - Y_i$

$o_{iC_ik} = 0$ $k = (K_i - Y_i) + 1, (K_i - Y_i) + 2, \dots, K_I$

4.2.3 Channel coding

Code blocks are delivered to the channel coding block. They are denoted by $o_{ir1}, o_{ir2}, o_{ir3}, \dots, o_{irK_i}$, where i is the TrCH number, r is the code block number, and K_i is the number of bits in each code block. The number of code blocks on TrCH i is denoted by C_i. After encoding the bits are denoted by $y_{ir1}, y_{ir2}, y_{ir3}, \dots, y_{irY_i}$. The encoded blocks are serially multiplexed so that the block with lowest index *r* is output first from the channel coding block. The bits output are denoted by $c_{i1}, c_{i2}, c_{i3}, \ldots, c_{iE_i}$, where *i* is the TrCH number and $E_i = C_i Y_i$. The output bits are defined by the following relations:

$$c_{ik} = y_{i1k} \quad k = 1, 2, \ldots, Y_i$$

$$c_{ik} = y_{i,2,(k-Y_i)} \quad k = Y_i + 1, Y_i + 2, \ldots, 2Y_i$$

$$c_{ik} = y_{i,3,(k-2Y_i)} \quad k = 2Y_i + 1, 2Y_i + 2, \ldots, 3Y_i$$

$$\ldots$$

$$c_{ik} = y_{i,C_i,(k-(C_i-1)Y_i)} \quad k = (C_i - 1)Y_i + 1, (C_i - 1)Y_i + 2, \ldots, C_i Y_i$$

The relation between o_{irk} and y_{irk} and between K_i and Y_i is dependent on the channel coding scheme.

The following channel coding schemes can be applied to TrCHs:

- Convolutional coding
- Turbo coding
- No channel coding

The values of Y_i in connection with each coding scheme:

- Convolutional coding, ½ rate: $Y_i = 2*K_i + 16$; 1/3 rate: $Y_i = 3*K_i + 24$
- Turbo coding, 1/3 rate: $Y_i = 3*K_i + 12$
- No channel coding, $Y_i = K_i$

Table 1: Error Correction Coding Parameters

Transport channel type	Coding scheme	Coding rate
BCH	Convolutional code	1/2
PCH		
FACH		
RACH		
CPCH		1/3, 1/2 or no coding
DCH		
CPCH	Turbo Code	1/3 or no coding
DCH		

If no code blocks are input to the channel coding ($C_i = 0$), no bits shall be output from the channel coding, i.e. $E_i = 0$.

The input bit sequence is denoted by $x_{i1}, x_{i2}, x_{i3}, \ldots, x_{iX_i}$ where i is the TrCH number and X_i is the number bits. The Fi output bit sequences per TTI are denoted by $y_{i,n_i1}, y_{i,n_i2}, y_{i,n_i3}, \ldots, y_{i,n_iY_i}$ where n_i is the radio frame number in current TTI and Y_i is the number of bits per radio frame for TrCH i. The output sequences are defined as follows:

$y_{i,n_ik} = x_{i,((n_i-1)Y_i)+k}$, $n_i = 1 \ldots F_i$, $j = 1 \ldots Y_i$

where

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

x_{ik} is the kth bit of the input bit sequence and

y_{i,n_ik} is the kth bit of the output bit sequence corresponding to the nth radio frame

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

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

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

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

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

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

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

4.2.7 Rate matching

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

The number of bits on a transport channel can vary between different transmission time intervals. In the downlink the transmission is interrupted if the number of bits is lower than maximum. When the number of bits between different transmission time intervals in uplink is changed, bits are repeated or punctured to ensure that the total bit rate after second 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 a 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 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* ($0 £ n_i < F_i$).

q: Average puncturing distance. 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 pattern for radio frame n_i. Used in uplink only.

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

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

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

e_{ini} Initial value of variable *e* in the rate matching pattern determination algorithm of section 4.2.7.4.

e_{plus} Increment of variable *e* in the rate matching pattern determination algorithm of section 4.2.7.4.

e_{minus} Decrement of variable *e* in the rate matching pattern determination algorithm of section 4.2.7.4.

X: Systematic bit in section 4.1.3.2.1.

Y: 1st parity bit (from the upper Turbo constituent encoder) in section 4.1.3.2.1.

Y': 2nd parity bit (from the lower Turbo constituent encoder) in section 4.1.3.2.1.

NOTE: Time index t in section 4.1.3.2.1 is omitted for simplify the rate matching description.

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:

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

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

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