Mueller Exhibit 23

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TSGR1#7(99)d76

Agenda item:

Source: Ericsson

Title: Text proposal for 25.212

Document for: Decision

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1 Introduction

This paper is an updated version of [1].

In Ad Hoc 4 the following points were identified and agreed:

- Section 4.2.5: physical channel segmentation should be replaced by radio frame segmentation.
- Section 4.2.6.3 x_m should be replaced by x_{im}.
- Section 4.2.11.1 The reference to DPCCH should be removed and it should be stated explicitly that the PhCH can be turned off.
- Section 4.2.11.2 The reference to DPCCH should be removed.

The document including these changes was recommended for approval by WG1.

After the Ad Hoc the following two editorial comments were received:

- Section 3.2: n should be replaced by n_i.
- Section 4.2.10 step 7: x_{pk} should be replaced by u_{pk}.

These two changes are also included in this updated text proposal.

In order to avoid discussion about how different text proposals should be merged, it was agreed in Ad Hoc 4 that this text proposal should include [2]-[4] and that the sections addressed by [5]-[6] should be excluded. The updated versions of [5]-[6] should reflect the changes proposed in [1].

2 References

[1] Ericsson, "TSGR1#7(99)b29 Proposal for new notation in 25.212".

[2] Ericsson, "TSGR1#7(99)b31 Comments on first multiplexing".

[3] Ericsson, "TSGR1#7(99)b30 DTX insertion in case of multicode".

[4] Ericsson, "TSGR1#7(99)b32 Transport block concatenation and code block segmentation".

[5] Mitsubishi Electric, "TSGR1#7(99)a80 Text proposal for DL rate matching signalling".

[6] Qualcomm, "TSGR1#(99)b05 Simplified transport block equalization and segmentation".

3 Text proposal for 25.212

3.2 Symbols

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

<symbol> <Explanation>

$\lceil x \rceil$	round towards ∞, i.e. integer such that $x \leq \lceil x \rceil < x+1$
$\lfloor x \rfloor$	round towards $-\infty$, i.e. integer such that $x-1 < \lfloor x \rfloor \leq x$
$\lvert x \rvert$	absolute value of x

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

i	TrCH number
j	TFC number
k	Bit number
l	TF number
m	Transport block number
n_i	Radio frame number of TrCH i.
p	PhCH number
r	Code block number
I	Number of TrCHs in a CCTrCH.
C_i	Number of code blocks in one TTI of TrCH i.
F_i	Number of radio frames in one TTI of TrCH i.
M_i	Number of transport blocks in one TTI of TrCH i.
P	Number of PhCHs used for one CCTrCH.
PL	Puncturing Limit for the uplink. Signalled from higher layers
RM_i	Rate Matching attribute for TrCH i. Signalled from higher layers.

3.3 Abbreviations

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

<ACRONYM> <Explanation>

ACS	Add, Compare, Select
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
DCH	Dedicated Channel
DL	Downlink (Forward link)
DPCH	Dedicated Physical Channel
DPCCH	Dedicated Physical Control Channel
DPDCH	Dedicated Physical Data Channel
DS-CDMA	Direct-Sequence Code Division Multiple Access
DSCH	Downlink Shared Channel
FACH	Forward Access Channel
FDD	Frequency Division Duplex
FER	Frame Error Rate
Mcps	Mega Chip Per Second

MS	Mobile Station
OVSF	Orthogonal Variable Spreading Factor (codes)
PCH	Paging Channel
PRACH	Physical Random Access Channel
PhCH	Physical Channel
RACH	Random Access Channel
RX	Receive
SCH	Synchronisation Channel
SF	Spreading Factor
SIR	Signal-to-Interference 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)

-- snip --

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 Section 4.2.1)
- Transport block concatenation and code block segmentation (see Section 4.2.2)
- Channel coding (see Section 4.2.3)
- Rate matching (see Section 4.2.6)
- Insertion of discontinuous transmission (DTX) indication bits (see Section 4.2.8~~7~~)
- Interleaving (two steps, see Section 4.2.4 and 4.2.10)
- Radio frame segmentation (see Section 4.2.5)
- Multiplexing of transport channels (~~two steps,~~ see Section ~~4.2.2 and~~ 4.2.7~~8~~)
- Physical channel segmentation (see Section 4.2.9)
- Mapping to physical channels (see Section 4.2.11)

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

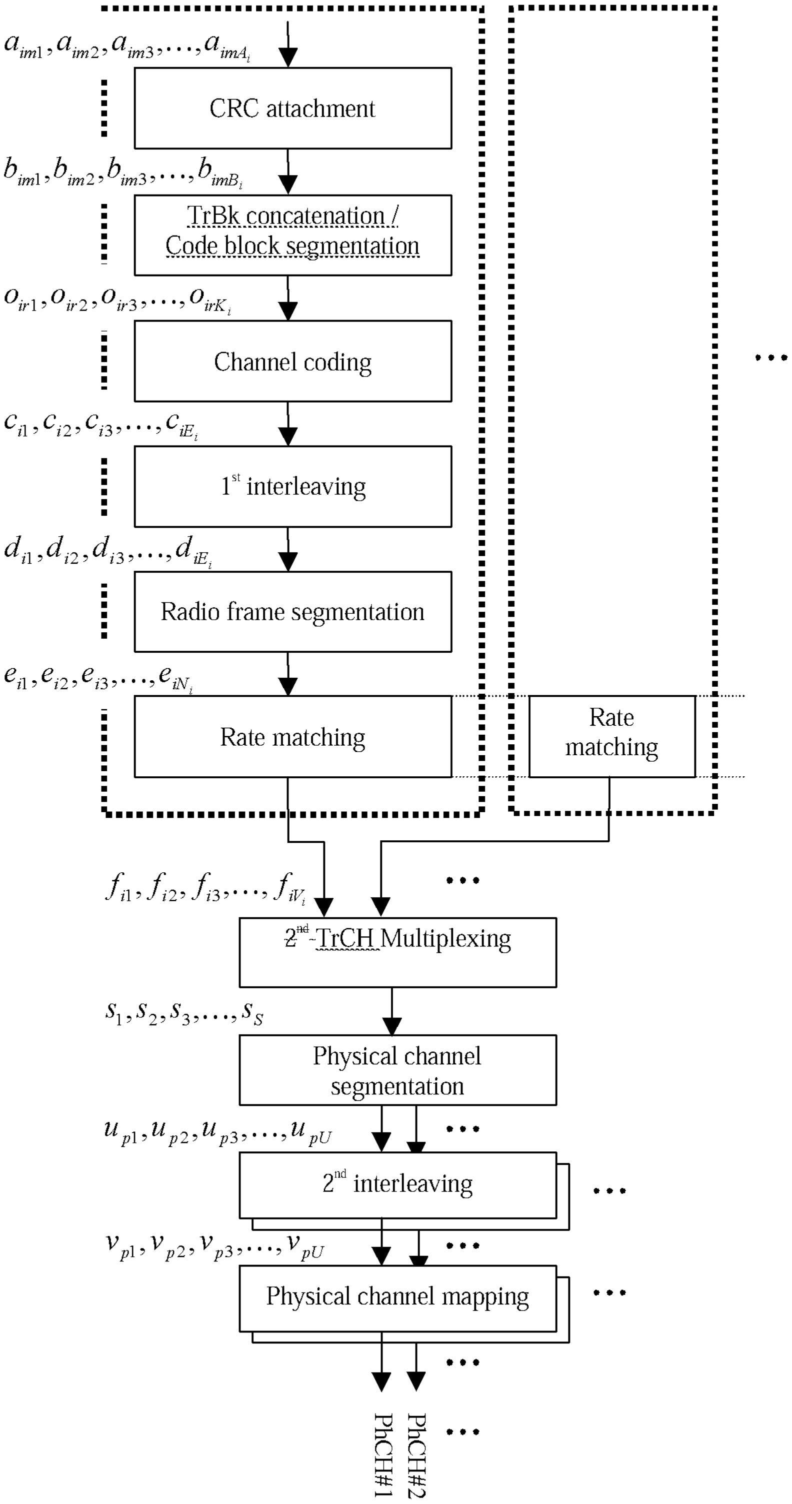
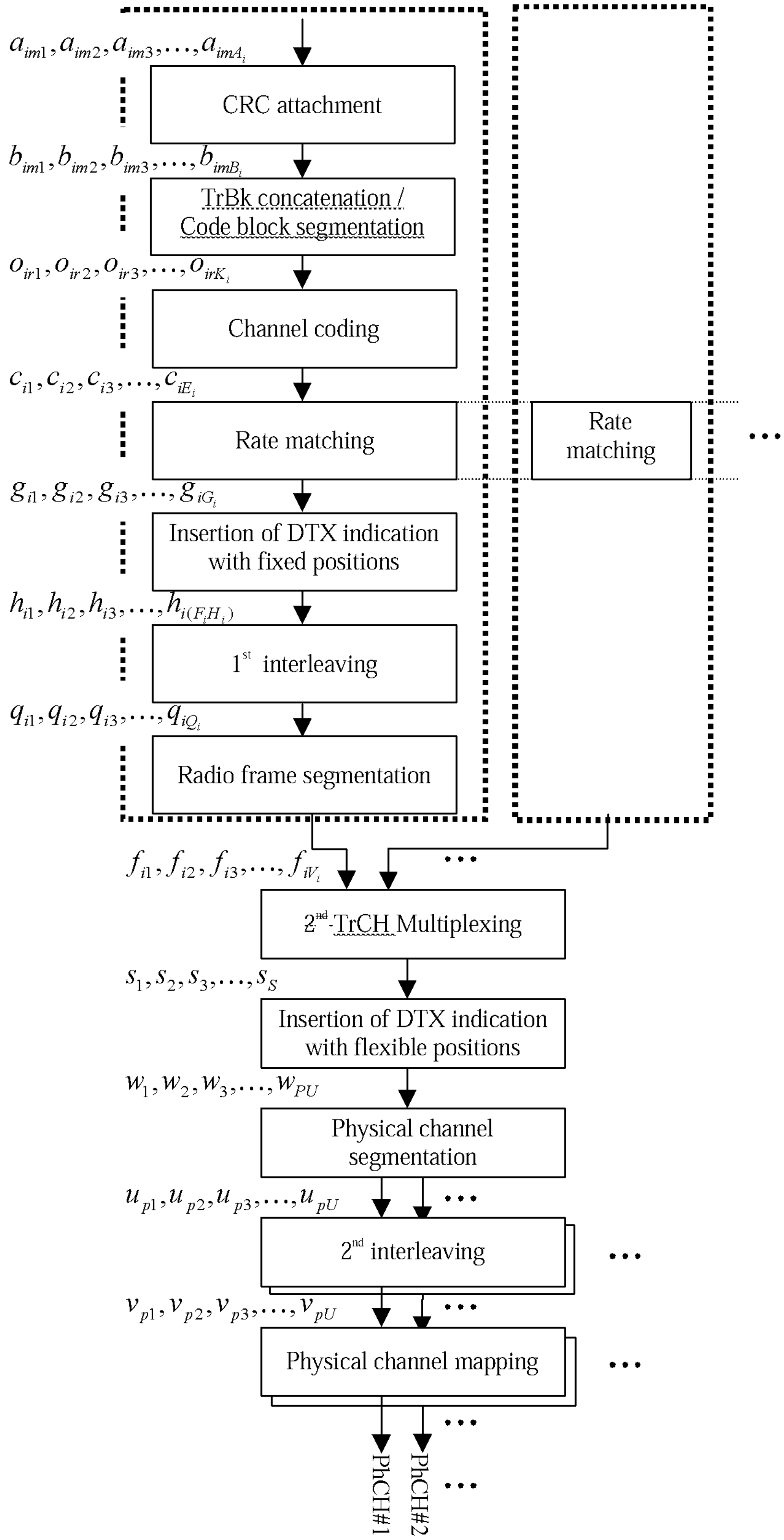


Figure 1. Transport channel multiplexing structure for uplink.



APLNDC-WH-A 0000010050

Figure 2. Transport channel multiplexing structure for downlink.

4.2.1 Error detection

Error detection is provided on transport blocks through a Cyclic Redundancy Check. The CRC is 16, 8 or 0 bits and it is signalled from higher layers what CRC length that should be used for each ~~transport channel~~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:

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

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

Denote the bits in a transport block delivered to layer 1 by $a_{im1}, a_{im2}, a_{im3}, \ldots, a_{imA_i}$ ~~$b_1, b_2, b_3, \ldots, b_N$~~, and the parity bits by $p_{im1}, p_{im2}, p_{im3}, \ldots, p_{imL_i}$ ~~$p_1, p_2, \ldots, p_L$~~. ~~N~~A_i is the length of ~~the~~a transport block of TrCH i, m is the transport block number, and L_i is 16, 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

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

~~$b_1D^{N+15} + b_2D^{N+14} + \ldots + b_ND^{16} + p_1D^{15} + p_2D^{14} + \ldots + p_{15}D^1 + p_{16}$~~

yields a remainder equal to 0 when divided by $g_{CRC16}(D)$. Similarly,

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

~~$b_1D^{N+7} + b_2D^{N+6} + \ldots + b_ND^{8} + p_1D^{7} + p_2D^{6} + \ldots + p_7D^1 + p_8$~~

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

4.2.1.2 Relation between input and output of the Cyclic Redundancy Check

~~Bits delivered to layer 1 are denoted $b_1, b_2, b_3, \ldots, b_N$, where N is the length of the transport block.~~ The bits after CRC attachment are denoted by $b_{im1}, b_{im2}, b_{im3}, \ldots, b_{imB_i}$ ~~$w_1, w_2, w_3, \ldots, w_{N+L}$, where L is 16, 8, or 0~~, where $B_i = A_i + L_i$. The relation between ~~b~~a_{imk} and ~~w~~b_{imk} is:

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

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

~~$w_k = b_k$ $\quad k = 1, 2, 3, \ldots, N$~~

~~$w_k = p_{(L+1-(k-N))}$ $\quad k = N+1, N+2, N+3, \ldots, N+L$~~

~~4.2.2 1st Multiplexing~~

~~Fix rate transport channels that are characterised by the same transport format attributes (as defined in 25.302) can be multiplexed before coding. When this multiplexing step is present, the transport blocks from different transport channels are serially concatenated. Denote the number of transport channels (TrCHs) by R, the number of transport blocks on each TrCH by P, and the number of bits in each transport block, including CRC bits, by K. The bits before multiplexing can then be described as follows:~~

~~Bits from transport block 1 of transport channel 1: $w_{111}, w_{112}, w_{113}, \ldots, w_{11K}$~~

~~Bits from transport block 2 of transport channel 1: $w_{121}, w_{122}, w_{123}, \ldots, w_{12K}$~~

~~...~~

~~Bits from transport block P of transport channel 1: $w_{1P1}, w_{1P2}, w_{1P3}, \ldots, w_{1PK}$~~

Bits from transport block 1 of transport channel 2: $w_{211}, w_{212}, w_{213}, \ldots w_{21K}$

...

Bits from transport block P of transport channel 2: $w_{2P1}, w_{2P2}, w_{2P3}, \ldots w_{2PK}$

...

Bits from transport block 1 of transport channel R: $w_{R11}, w_{R12}, w_{R13}, \ldots w_{R1K}$

...

Bits from transport block P of transport channel R: $w_{RP1}, w_{RP2}, w_{RP3}, \ldots w_{RPK}$

The bits after first multiplexing are denoted by $d_1, d_2, d_3, \ldots d_M$, and defined by the following relations:

$d_k = w_{11k}$ $k = 1, 2, \ldots, K$

$d_k = w_{12(k-K)}$ $k = K + 1, K + 2, \ldots, 2K$ TrCH 1

...

$d_k = w_{1P(k-(P-1)K)}$ $k = (P - 1)K + 1, \ldots, PK$

$d_k = w_{21(k-PK)}$ $k = PK + 1, \ldots, (P + 1)K$

... TrCH 2

$d_k = w_{2P(k-(2P-1)K)}$ $k = (2P - 1)K + 1, \ldots, 2PK$

...

$d_k = w_{R1(k-(R-1)PK)}$ $k = (R - 1)PK + 1, \ldots, ((R - 1)P + 1)K$

..... TrCH R

$d_k = w_{RP(k-(RP-1)K)}$ $k = (RP - 1)K + 1, \ldots, RPK$

<Note: Above it is assumed that all transport blocks have the same size. There are cases when the total number of bits that are sent during a transmission time interval is not a multiple of the number of transport blocks. A few padding bits are then needed but the exact insertion point (in the multiplexing chain) of these bits is for further study.>

4.2.2 Transport block concatenation and code block segmentation

All transport blocks in a TTI are serially concatenated. If the number of bits in a TTI is larger than Z, then code block segmentation is performed after the concatenation of the transport blocks. The maximum size of the code blocks depend on if convolutional or turbo coding is used for the TrCH.

4.2.2.1 Concatenation of transport blocks

The bits input to the transport block concatenation are denoted by $b_{im1}, b_{im2}, b_{im3}, \ldots, b_{imB_i}$ where i is the TrCH number, m is the transport block number, and B_i is the number of bits in each block (including CRC). The number of transport blocks on TrCH i is denoted by M_i. The bits after concatenation are denoted by $x_{i1}, x_{i2}, x_{i3}, \ldots, x_{iX_i}$, where i is the TrCH number and $X_i = M_i B_i$. They are defined by the following relations:

$x_{ik} = b_{i1k}$ $k = 1, 2, \ldots, B_i$

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

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

$\ldots$

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

4.2.2.2 Code block segmentation

<Ericsson's note: It is proposed that filler bits are set to 0.>

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: $Z = 512 - K_{tail}$

turbo coding: $Z = 5120 - K_{tail}$

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: $K_i = \lceil X_i / C_i \rceil$

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

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

If $X_i \ge Z$, then

$o_{i1k} = x_{ik}$ $k = 1, 2, \ldots, K_i$

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

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

$\ldots$

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

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

4.2.3 Channel coding

Code blocks are delivered to the channel coding block. They are denoted by $o_{ir1}, o_{ir2}, o_{ir3}, \ldots, o_{irK_i}$, 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 $x_{ir1}, x_{ir2}, x_{ir3}, \ldots, x_{irX_i}$. 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 $E_i = C_iX_i$. The output bits are defined by the following relations:

$c_{ik} = x_{i1k}$ $k = 1, 2, \ldots, X_i$

$c_{ik} = x_{i,2,(k-X_i)}$ $k = X_i + 1, X_i + 2, \ldots, 2X_i$

$c_{ik} = x_{i,3,(k-2X_i)}$ $k = 2X_i + 1, 2X_i + 2, \ldots, 3X_i$

$\ldots$

$c_{ik} = x_{i,C_i,(k-(C_i-1)X_i)}$ $k = (C_i - 1)X_i + 1, (C_i - 1)X_i + 2, \ldots, C_iX_i$

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

The following channel coding schemes can be applied to transport channelTrCHs.

- Convolutional coding
- Turbo coding
- No channel coding

Table 1. Error Correction Coding Parameters

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

Note1: The exact physical layer encoding/decoding capabilities for different code types are FFS.
Note2: In the UE the channel coding capability should be linked to the terminal class.

<Ericsson's note: Combined mode is assumed as indicated in the introduction.>

<Editor's note: Combined or segmented mode with Turbo coding is F.FS.>

4.2.3.1 Convolutional coding

4.2.3.1.1 Convolutional coder

- Constraint length K=9. Coding rate 1/3 and ½.
- The configuration of the convolutional coder is presented in Figure 4-3.
- The output from the convolutional coder shall be done in the order starting from output0, output1, and output2, output0, output1, ..., output2. (When coding rate is 1/2, output is done up to output 1).
- K-1 tail bits (value 0) shall be added to the end of the codeing block before encoding.
- The initial value of the shift register of the coder shall be "all 0".

-- snip --

4.2.3.1.2Segmentation into code blocks for convolutional coding

<Note: It is for further study if the maximum code block size is 504 or shorter.>

If the transport blocks or multiplexed transport blocks are longer than [504] bits (including CRC bits), they are segmented before convolutional encoding. Denote the number of transport blocks before coding by P and the number of bits in each transport block or the sum of the number of bits in the multiplexed blocks by M. Note that if first multiplexing is performed, all transport blocks of a transport channel in the same transmission time interval are multiplexed together, i.e. P=1. The bits before segmentation can then be described as follows:

Bits in transport block 1before segmentation: $d_{1,1}, d_{1,2}, d_{1,3}, \ldots d_{1,M}$
Bits in transport block 2 before segmentation: $d_{2,1}, d_{2,2}, d_{2,3}, \ldots d_{2,M}$
….
Bits in transport block P before segmentation: $d_{P,1}, d_{P,2}, d_{P,3}, \ldots d_{P,M}$
If $M \le [504]$, no segmentation is performed. If $M > [504]$ the following parameters are calculated:
Number of code blocks: $S = \text{round\_up}(PM / [504])$
Length of coded blocks: $C = \text{round\_up}(PM / S)$
Remainder: $R = PM - S\,\text{round\_down}(PM / S)$
Number of filler bits: $F = S - R$, if $R \neq 0$
$F = 0$, if $R = 0$
round_up(x) means the smallest integer number larger or equal to x.
round_down(x) means the largest integer number smaller or equal to x.
The F filler bits are appended to the end of the last code block before tail insertion and channel encoding. They are denoted $f_1, f_2, f_3, \ldots f_F$. The bits after segmentation are denoted by $u_{1,1}, u_{1,2}, u_{1,3}, \ldots u_{1,C}, u_{2,1}, u_{2,2}, u_{2,3}, \ldots, u_{2,C}, \ldots u_{S,1}, u_{S,2}, u_{S,3}, \ldots, u_{S,C}$, and defined by the following relations:

$u_{1,k} = d_{1,k}$ $k = 1, 2, 3, \ldots C$
$u_{2,(k-C)} = d_{1,k}$ $k = C + 1, C + 2, C + 3, \ldots 2C$
…
$u_{j,(k-(j-1)C)} = d_{1,k}$ $k = (j-1)C + 1, (j-1)C + 2, (j-1)C + 3, \ldots M$
$u_{j,(k-(j-1)C)} = d_{2,(k-M)}$ $k = M + 1, M + 2, M + 3, \ldots jC$
$u_{j+1,(k-jC)} = d_{2,(k-M)}$ $k = jC + 1, jC + 2, jC + 3, \ldots (j+1)C$
…
$u_{S,(k-(S-1)C)} = d_{P,(M-C+F+k-(S-1)C)}$ $k = (S-1)C + 1, (S-1)C + 2, (S-1)C + 3, \ldots SC - F$
$u_{S,(k-(S-1)C)} = f_{k-SC+F}$ $k = SC - F + 1, SC - F + 2, SC - F + 3, \ldots SC$

<Note: Above it is assumed that all transport blocks have the same size. There are cases when the total number of bits that are sent during a transmission time interval is not a multiple of the number of transport blocks. A few padding bits are then needed but the exact insertion point (in the multiplexing chain) of these bits is for further study.>

-- snip --

4.2.3.2.4 Encoding blocks for Turbo code

Input data blocks for a turbo encoder consist of the user data and possible extra data being appended to the user data before turbo encoding. The encoding segments for a turbo encoder are defined in terms of systematic bits. The segment includes the user data, a possible error detection field (CRC), possible filler bits, and the termination. Each encoding segment is six bits longer than its associate Turbo code internal interleaver. The Algorithm for combining and segmentation is as follows:

Inputs:

N_{DATA} size of input data block to turbo encoder

N_{TAIL} number of tail bits to be appended to the encoding segments (termination) is 6

Outputs:

N_S number of segments

N_{TB} number of bits in the turbo encoder input segments

N_{FILL} number of filler (zero) bits in the last turbo encoder input segment

K a length of a Turbo code internal interleaver to be applied

Do:

1. Let N_S = round_up(N_{DATA} / (5120 – N_{TAIL}))

2. Let N_{TB} = round_up (N_{DATA} / N_S) + N_{TAIL};

3. Let N_{REM} = remainder of N_{DATA} / N_S;

4. If N_{REM} not equal to 0 then insert N_{FILL} = (N_S – N_{REM}) zero bits to the end of the input data else N_{FILL} = 0.

5. K = N_{TB} – N_{TAIL};

6. End.

Here *round_up(x)* stands for an smallest interger number being larger or equal to *x*.

All turbo encoder input segments are of equal size and therefore the same turbo interleaver can be used for all turbo segments. A number of systematic bits over an entire channel interleaving block at output of the encoder is

N_S * (round_up(N_{DATA} / N_S) + N_{TAIL}).

The N_{FILL} filler bits are padded to the end of the last encoding segment in order to make the last segment equal size to the precedent ones. The filler bits are encoded.

-- snip --

4.2.4 1st interleaving

-- snip --

4.2.5 Radio frame segmentation

-- snip --

4.2.6 Rate matching

-- snip --

4.2.6.4 Relation between input and output of the rate matching block in uplink

The bits input to the rate matching are denoted by $e_{i1}, e_{i2}, e_{13}, \ldots, e_{iN_i}$, where *i* is the TrCH.

Hence, $x_{ik} = e_{ik}$ and $N = N_{ij} = N_i$.

The bits output from the rate matching are denoted by $f_{i1}, f_{i2}, f_{13}, \ldots, f_{iV_i}$, where *i* is the TrCH number and $V_i = N + \Delta N = N_{ij} + \Delta N_{ij}$.

Note that the transport format combination number *j* for simplicity has been left out in the bit numbering.

4.2.6.5 Relation between input and output of the rate matching block in downlink

The bits input to the rate matching are denoted by $c_{i1}, c_{i2}, c_{13}, \ldots, c_{iE_i}$, where *i* is the TrCH number and *l* the transport format number. Hence, $x_{ik} = e_{ik}$ and $N = N_{il}^{TTI} = E_i$.

The bits output from the rate matching are denoted by $g_{i1}, g_{i2}, g_{13}, \ldots, g_{iG_i}$, where *i* is the TrCH number and $G_i = N + \Delta N = N_{il}^{TTI} + \Delta N_{il}^{TTI}$.

Note that the transport format number *l* for simplicity has been left out in the bit numbering.

4.2.7 4.2.8 2nd TrCH Mmultiplexing

For both uplink and downlink, radio frames in each channel coding and multiplexing chains are serially multiplexed into a 10 msec coded composite transport channel.Every 10 ms, one radio frame from each TrCH is delivered to the TrCH multiplexing. These radio frames are serially multiplexed into a coded composite transport channel (CCTrCH).

Figure A 3 and A 4 illustrate data flow from 1st interleaver down to 2nd interleaver in both uplink and downlink channel coding and multiplexing chains. In the figures, it is assumed that there are N different channel coding and multiplexing chains. Following subsection describes the input-output relationship of 2nd multiplexing in bit wise manner, referring to the notations in Figure A 3 and A 4, where the notation in each data block, for examples L_1, R_1, K_1, P, M, etc., indicate number of bits of the data block.
The bits input to the TrCH multiplexing are 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 in the radio frame of TrCH i. The number of TrCHs is denoted by I. The bits output from TrCH multiplexing are denoted by $s_1, s_2, s_3, \ldots, s_S$, where S is the number of bits, i.e. $S = \sum_i V_i$. The TrCH multiplexing is defined by the following relations:

$s_k = f_{1k}$ $k = 1, 2, \ldots, V_1$

$s_k = f_{2,(k-V_1)}$ $k = V_1+1, V_1+2, \ldots, V_1+V_2$

$s_k = f_{3,(k-(V_1+V_2))}$ $k = (V_1+V_2)+1, (V_1+V_2)+2, \ldots, (V_1+V_2)+V_3$

…

$s_k = f_{I,(k-(V_1+V_2+\ldots+V_{I-1}))}$ $k = (V_1+V_2+\ldots+V_{I-1})+1, (V_1+V_2+\ldots+V_{I-1})+2, \ldots, (V_1+V_2+\ldots+V_{I-1})+V_I$

4.2.7.1 4.2.8.1 Second multiplexing in uplink

The bits before second multiplexing in uplink are described as follows:

Bits from rate matching 1: $c_{11}, c_{12}, \ldots c_{1K_1}$

Bits from rate matching 2: $c_{21}, c_{22}, \ldots c_{2K_2}$

Bits from rate matching 3: $c_{31}, c_{32}, \ldots c_{3K_3}$

.....

Bits from rate matching N: $c_{N1}, c_{N2}, \ldots c_{NK_N}$

The bits after second multiplexing are denoted by $d_1, d_2, \ldots, d_P$
and defined by the following relationships:

For $j=1,2,3 \ldots,P$ where $P=K_1+K_2+\ldots+K_N$

$d_j = c_{1j}$ $j=1,2,\ldots K_1$

$d_j = c_{2,(j-K_1)}$ $j=K_1+1, K_1+2, \ldots, K_1+K_2$

$d_j = c_{3,(j-(K_1+K_2))}$ $j=(K_1+K_2)+1, (K_1+K_2)+2, \ldots, (K_1+K_2)+K_3$

....

$d_j = c_{N,(j-(K_1+K_2+\ldots+K_{N-1}))}$ $j=(K_1+K_2+\ldots+K_{N-1})+1, (K_1+K_2+\ldots+K_{N-1})+2, \ldots, (K_1+K_2+\ldots+K_{N-1})+K_N$

~~4.2.7.24.2.8.2 Second multiplexing in downlink~~

~~The bits before second multiplexing in downlink are described as follows:~~

~~Bits from radio frame segmentation 1: $c_{11}, c_{12}, \ldots c_{1K_1}$~~

~~Bits from radio frame segmentation 2: $c_{21}, c_{22}, \ldots c_{2K_2}$~~

~~Bits from radio frame segmentation 3: $c_{31}, c_{32}, \ldots c_{3K_3}$~~

~~...~~

~~Bits from radio frame segmentation N: $c_{N1}, c_{N2}, \ldots c_{NK_N}$~~

~~The bits after second multiplexing are denoted by $d_1, d_2, \ldots, d_P$ and defined by the following relationship:~~

~~For $j = 1,2,3 \ldots, P$ where $P = K_1 + K_2 + \ldots + K_N$~~

~~$d_j = c_{1j}$ $j = 1, 2, \ldots K_1$~~

~~$d_j = c_{2,(j-K_1)}$ $j = K_1+1, K_1+2, \ldots, K_1+K_2$~~

~~$d_j = c_{3,(j-(K_1+K_2))}$ $j = (K_1+K_2)+1, (K_1+K_2)+2, \ldots, (K_1+K_2)+K_3$~~

~~...~~

~~$d_j = c_{N,(j-(K_1+K_2+\ldots+K_{N-1}))}$ $j = (K_1+K_2+\ldots+K_{N-1})+1, (K_1+K_2+\ldots+K_{N-1})+2, \ldots, (K_1+K_2+\ldots+K_{N-1})+K_N$~~

4.2.8 ~~4.2.7~~ Insertion of discontinuous transmission (DTX) indication bits

<Ericsson's note: It is Ericsson's understanding that fixed or flexible positions is chosen on CCTrCH basis (not TrCH).>

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 ~~transport channel~~TrCHs in the radio frame are used ~~in the radio frame~~. It is up to the UTRAN to decide for each CCTrCH whether fixed or flexible positions are used during the connection ~~for each transport channel~~. DTX indication bits only indicate when the transmission should be turned off, they are not transmitted.

4.2.8.1 ~~4.2.7.1~~ Insertion of DTX indication bits with fixed positions

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

~~Denote t~~The bits from rate matching ~~block~~are denoted by $g_{i1}, g_{i2}, g_{i3}, \ldots, g_{iG_i}$ ~~$r_1, r_2, r_3, \ldots, r_N$~~, where G_i~~N~~ is the number of ~~these~~ bits ~~per L*10 ms, which is~~ in one TTI of TrCH i~~the transmission time interval~~. ~~r_1 is the first input bit to this block and r_N is the last input bit into this block.~~ Denote the number of bits reserved f~~r~~om one radio frame of~~or~~ TrCH i~~this transport channel (or fix rate TrCHs with the same transport format attributes)~~ by H_i~~M~~, i.e. the maximum number of bits in a radio frame for any transport format of TrCH i. The number of radio frames in a TTI of TrCH i is denoted by F_i. The bits output from the DTX insertion are denoted by $h_{i1}, h_{i2}, h_{i3}, \ldots, h_{i(F_iH_i)}$. Note that these bits are three valued. They are defined by the following relations:~~After inserting the DTX indication bits, there are three valued symbols s_k. They can be described as follows:~~

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

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

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

~~$s_k = r_k$ $k=1,2,3,\ldots,N$~~

~~$s_k = x$ $k=N+1, N+2, N+3, \ldots, LM$~~

where DTX indication bits are denoted by x. Here $r_k \in \{0,1\}$ and $x \notin \{0,1\}$. s_1 is the first output symbol from this block and s_{LM} is the last output symbol from this block.

4.2.8.2 4.2.7.2 Insertion of DTX indication bits with flexible positions

<Note: Below, it is assumed that all physical channels belonging to the same CCTrCH use the same SF. Hence, U_p=U=constant.>

This step of inserting DTX indication bits is used only if the positions of the transport channelTrCHs in the radio frame are use flexible position scheme. In flexible position scheme transport channels have been concatenated one after another in the 2nd multiplexing step. The DTX indication bits shall be placed at the end of the radio frame. Note that the DTX will be distributed over all slots after 2nd interleaving., after all the encoded data bits.

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 U.

The bits output from the DTX insertion block are denoted by $w_1, w_2, w_3, \ldots, w_{(PU)}$. Note that these bits are threevalued. They are defined by the following relations:

Denote the bits from physical channel segmentation into one physical channel by $p_1, p_2, p_3, \ldots, p_N$, where N is the number of these bits per one radio frame. p_1 is the first input bit to this block and p_N is the last input bit to this block. Denote the number of bits that can be fitted to DPDCH field of one radio frame by M. After insertion of the DTX indication bits, there are three valued symbols s_k. They can be described as follows:

$w_k = s_k$ $s_k = p_k$ $k = 1, 2, 3, \ldots, N S$

$w_k = \delta$ $s_k = x$ $k = SN+1, SN+2, SN+3, \ldots, PUM$

where DTX indication bits are denoted by $x\delta$. Here $ps_k \in \{0, 1\}$ and $x\delta \notin \{0, 1\}$. s_1 is the first output symbol from this block and s_M is the last output symbol from this block.

4.2.9 Physical channel segmentation

<Editor's note: for physical channel segmentation, it is assumed that the segmented physical channels use the same SF.><Note: Below, it is assumed that all physical channels belonging to the same CCTrCH use the same SF. Hence, U_p=U=constant.>

Data after multiplexing of transport channels with different QoS can get segmented into multiple physical channels, which are transmitted in parallel during 10ms interval.

Figure A-3 and A-4 illustrate data flow from 1st interleaver down to 2nd interleaver in both uplink and downlink channel coding and multiplexing chains. In the figures, it is assumed that there are N different channel coding and multiplexing chains, and M physical channels. The following subsection describes input-output relationship of physical channel segmentation in bit-wise manner, referring to the notations in Figure A-3 and A-4, where the notation in each data block, for examples L_1, R_1, K_1, P/M, etc., indicate number of bits of the data block.

The bits before physical channel segmentation are described as follows:

Bits from second multiplexing: $d_1, d_2, \ldots, d_P$

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 $x_1, x_2, x_3, \ldots, x_Y$, where Y is the number of bits input to the physical channel segmentation block. The number of PhCHs is denoted by P.

M is the number of physical channel

The bits after physical channel segmentation are denoted $u_{p1}, u_{p2}, u_{p3}, \ldots, u_{pU}$, where p is PhCH number and U is the number of bits in one radio frame for each PhCH, i.e. $U = \frac{Y}{P}$. The relation between x_k and u_{pk} is given below.defined by the following relationship:

The first physical channel bBits on first PhCH after physical channel segmentation:

$u_{1k} = x_k$ $k = 1, 2, \ldots, U$

$e_{1j} = d_j$ $j = 1, 2, \ldots, P/M$

The second physical channel bBits on second PhCH after physical channel segmentation:

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

$e_{2j} = d_{(j+P/M)}$ $j = 1, 2, \ldots, P/M$

…

The M^{th} physical channel bBits on the P^{th} PhCH after physical channel segmentation:

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

$e_{Mj} = d_{(j+(M-1)P/M)}$ $j = 1, 2, \ldots, P/M$

4.2.9.1 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 $Y = S$.

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

If fixed positions of the TrCHs in a radio frame are used then 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 $Y = S$.
If flexible positions of the TrCHs in a radio frame are used then 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 $Y = PU$.

4.2.10 2nd interleaving

The 2nd interleaving of channel interleaving consists of two stage operations is a block interleaver with inter-column permutations. The bits input to the 2nd interleaver are denoted $u_{p1}, u_{p2}, u_{p3}, \ldots, u_{pU}$, where p is PhCH number and U is the number of bits in one radio frame for one PhCH. In first stage, the input sequence is written into rectangular matrix row by row. The second stage is inter-column permutation. The two stage operations are described as follows, the input block length is assumed to be K_2.

First Stage:

(1) (1) Set a column the number of columns $C_2 = 30$. The columns are numbered 0, 1, 2, …, C_2-1 from left to right.

(2) (2) Determine a rowthe number of rows R_2 by finding minimum integer R_2 such that, $UK_2 <= \leq R_2 \times C_2$.

(3) (3) The bits input sequence ofto the 2nd interleaving isare written into the $R_2 \times C_2$ rectangular matrix

row by row.

$$\begin{bmatrix} u_{p1} & u_{p2} & u_{p3} & \cdots & u_{p30} \\ u_{p31} & u_{p32} & u_{p33} & \cdots & u_{p60} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ u_{p,((R_2-1)30+1)} & u_{p,((R_2-1)30+2)} & u_{p,((R_2-1)30+3)} & \cdots & u_{p,(R_2 30)} \end{bmatrix}$$

~~**Second Stage:**~~

(4) ~~(1)~~ Perform the inter-column permutation based on the pattern $\{P_2(j)\}$ $(j = 0, 1, ..., C_2-1)$ that is shown in Table 4-4, where $P_2(j)$ is the original column position of the j-th permuted column. After permutation of the columns, the bits are denoted by y_{pk}.

$$\begin{bmatrix} y_{p1} & y_{p,(R_2+1)} & y_{p,(2R_2+1)} & \cdots & y_{p,(29R_2+1)} \\ y_{p2} & y_{p,(R_2+2)} & y_{p,(2R_2+2)} & \cdots & y_{p,(29R_2+2)} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ y_{pR_2} & y_{p,(2R_2)} & y_{p,(3R_2)} & \cdots & y_{p,(30R_2)} \end{bmatrix}$$

(5) ~~(2)~~ The output of the 2nd interleaving is the bit sequence read out column by column from the inter-column permuted $R_2 \times C_2$ matrix. ~~and t~~The output is pruned by deleting bits that were not present in the input bit sequence, i.e. bits y_{pk} that corresponds to bits u_{pk} with $k>U$ are removed from the output. ~~non-existence bits in the input sequence, where the deleting bits number L_2 is defined as: L_2 = $R_2 \times C_2 - K_2$.~~ The bits after 2nd interleaving are denoted by $v_{p1}, v_{p2}, \ldots, v_{pU}$, where v_{p1} corresponds to the bit y_{pk} with smallest index k after pruning, v_{p2} to the bit y_{pk} with second smallest index k after pruning, and so on.

Table 4-4

~~Column n~~Number of columns C_2	Inter-column permutation pattern
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}

4.2.11 Physical channel mapping

The PhCH for both uplink and downlink is defined in [2]. The bits input to the physical channel mapping are denoted by $v_{p1}, v_{p2}, \ldots, v_{pU}$, where p is the PhCH number and U is the number of bits in one radio frame for one PhCH. The bits v_{pk} are mapped to the PhCHs so that the bits for each PhCH are transmitted over the air in ascending order with respect to k.

~~4.2.1.1~~4.2.11.1 Uplink

~~On the uplink, transport data after 2nd interleaving is mapped onto one DPDCH. Continuous transmission is applied for uplink DPDCH at all times.~~ In uplink, the PhCHs used during a radio frame are either completely filled with bits that are transmitted over the air or not used at all.

~~4.2.1.2~~4.2.11.2 Downlink

In downlink, the PhCHs do not need to be completely filled with bits that are transmitted over the air. Bits $v_{pk} \notin \{0, 1\}$ are not transmitted.

~~On the downlink, transport data after 2nd interleaving is mapped onto data fields in one DPDCH, which is defined in TS 25.211. If the total bit rate after transport channel multiplexing is not identical to the total channel bit rate of the allocated dedicated physical channels, discontinuous transmission is used.~~

~~If transport data is less than the number of DPDCH bits in a radio frame, the DPDCH transmission~~

can be turn off for data absent.

The transmission of the DPDCH symbols shall be ON, only if there is data to transmit. If there is no data, the transmission shall be OFF.

For transport channelTrCHs not relying on TFCI for transport format detection (blind transport format detection), the positions of the transport channels within the radio frame should be fixed.
For transport channelTrCHs relying on TFCI for transport format detection, the UTRAN decides higher layers signal whether the positions of the transport channels should be fixed or flexible.
Pilot and TPC symbols are always transmitted regardless of th e data existence.*<Ericsson's note: This is clear from 25.211 since the corresponding fields always are filled with bits.>*

A.3 Data Flow from Radio Frame Segmentation to Physical Channel Segmentation

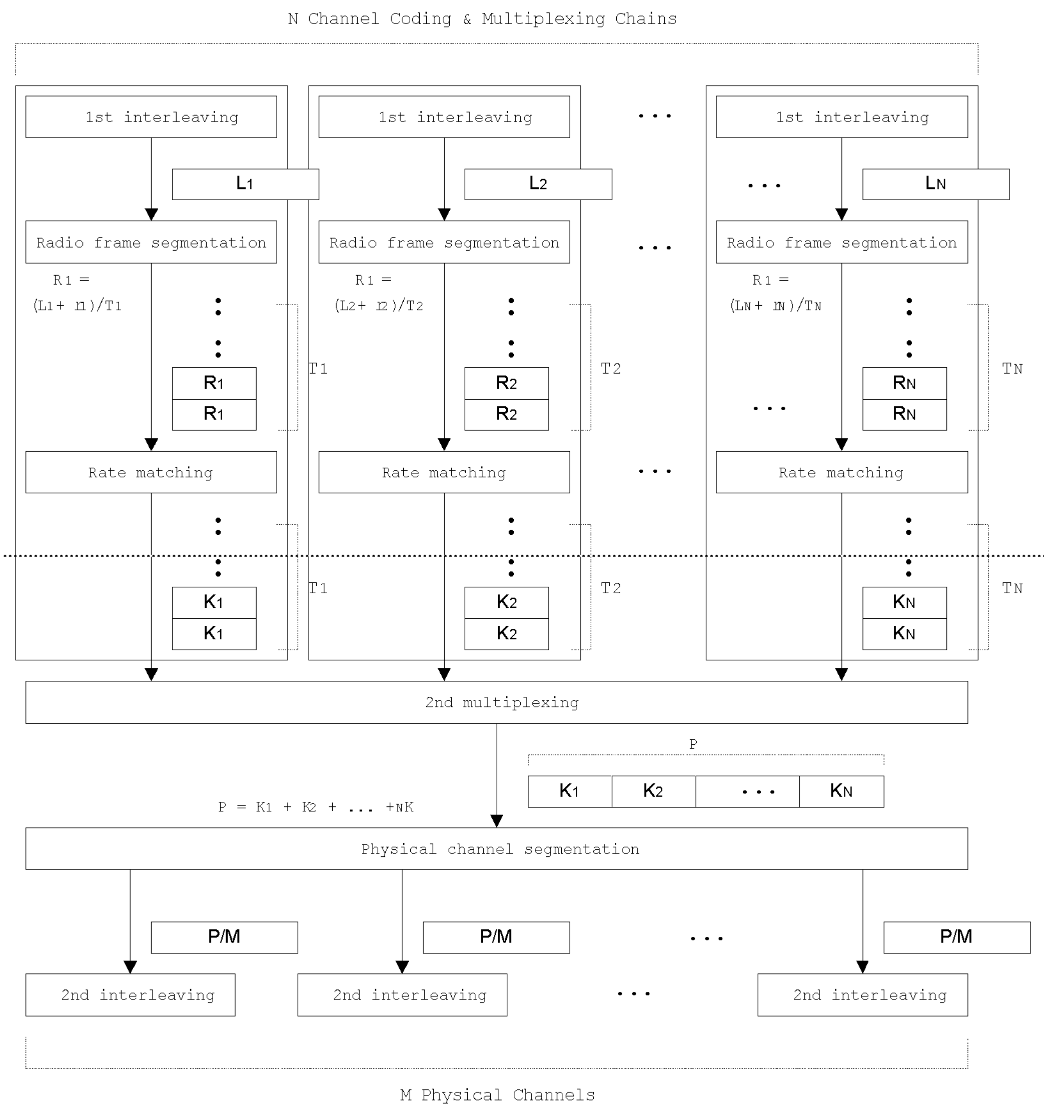
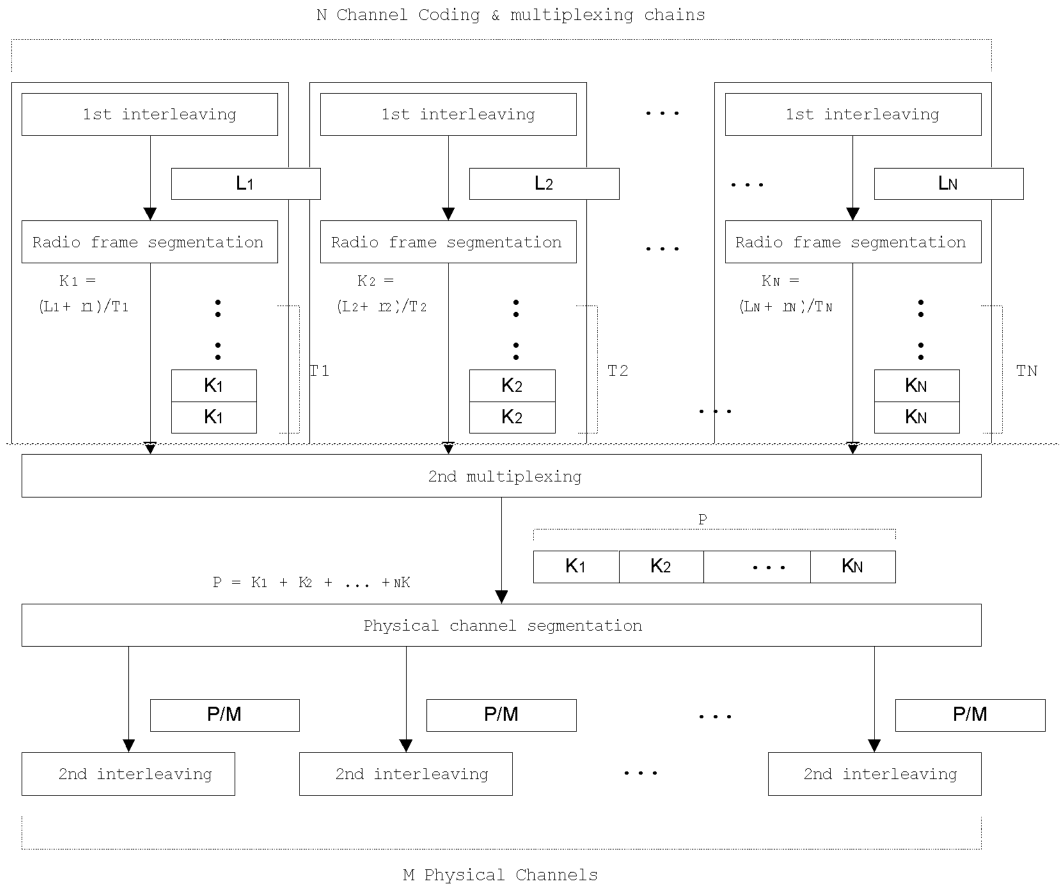


Figure A-3 Part of uplink channel coding and multiplexing chains



~~***Figure A-4. Part of downlink channel coding and multiplexing chains***~~