TSG-RAN Working Group 1 Meeting **TSGR1#7(99)b94**
Hannover, Germany
August 30-September 3, 1999

Agenda item:

Source: Samsung Electronics Co.

Title: Updated text proposal of radio frame segmentation, 2nd multiplexing, and physical channel segmentation for 25.212 and 25.222

Document for: Decision

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1. Introduction

This document presents an updated text proposal of radio frame segmentation, 2nd multiplexing, and physical channel segmentation to maintain notational consistency as much as possible in 25.212 and 25.222 [1][2]. In addition, the figures in the Annex for 25.212 should not be considered for information only. In stead, it is appropriate to be considered for parts of the specification to explain exact procedures for those three functional blocks.

2. Updated text proposal

2.1. Text for 25.212 (FDD)

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4.2.5. Radio frame segmentation

Each transport channel with transmission time interval 10, 20, 40, or 80 msec is segmented into 10 msec equi-sized~~ data blocks~~ radio frames. Those~~ segmented~~ 1, 2, 4, or 8 ~~blocks~~radio frames, depending on transmission time interval, are output to rate matching for uplink and 2nd multiplexing for downlink in block-wise order at every 10 msec.
Figure B-1 and B-2 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. The following subsections describe input-output relationship of radio frame segmentation~~ in bit-wise manner~~, referring to the notations in Figure B-1 and B-2, where the notations in each data block, for examples L_1, R_1, K_1, ~~P/M,~~ etc., indicate number of bits of the data block.
Define some notations:

L_i = Size of i^{th} transport channel data in bits to radio frame segmentation

~~T~~F_i = Transmission Time Interval of i^{th} ~~channel coding and multiplexing chain~~ transport channel (msec) / 10 (msec)

So, ~~T~~$F_i \in \{1, 2, 4, 8\}$ for $i = 0, 1, 2, \ldots, N$

4.2.5.1 Radio frame size equali~~z~~sation

i^{th} transport channel data of size L_i is segmented into radio frames of size L_i/~~T~~F_i. Since the size of radio frame, L_i/~~T~~F_i is not necessarily an integer, some of ~~T~~F_i the radio frames will contain one bit less than others. For systematic process of the proceeding functional blocks, the radio frame sizes are equalized to be one finite size by considering the number of proper filler bits. Note that maximum possible filler bits are 7 for transmission time interval of 80 msec. These filler bits are evenly distributed over the one-bit short radio frames. Following is the algorithm of radio frame size equalization.

```
$\cancel{t}\,k$ = radio frame index $(1, 2, 3, \ldots, \cancel{T}F_i)$ for a given $i^{th}$ channel coding and multiplexing chain
$r_i = (\cancel{T}F_i - (L_i \bmod \cancel{T}F_i)) \bmod F_i$ Î $\{0, 1, 2, \ldots, \cancel{T}F_i-1\}$     // number of filler bits
$(L_i + r_i)/\cancel{T}F_i = R_i$                        // Target radio frame size for uplink
$(L_i + r_i)/\cancel{T}F_i = K_i$                        // Target radio frame size for downlink
If $r_i$ ¹ 0 then
  For each $\cancel{t}k$ (³ $T_i$-$r_i$+1)
  Add one filler bit to the end of $\cancel{t}k^{th}$ radio frame
  End
End If
```

4.2.5.2 Radio frame segmentation rule

Parameter r_i for segmentation are determined in radio frame size equalization.

The bits before radio frame segmentation for i^{th} channel coding and multiplexing chain are denoted by:
$b_{i1}, b_{i2}, \ldots b_{iL_i}$

Bits after radio frame segmentation block are 10 msec-based and denoted by:
$c_{i1}, \ldots c_{i,(L_i+r_i)/\cancel{T}F_i}$
and related to the input bits to radio frame segmentation as follows.

Bits after radio frame segmentation in the first 10 msec time interval: $(\cancel{t}k=1)$
$c_{ij} = b_{ij}$ $j=1,2,\ldots, (L_i+r_i)/\cancel{T}F_i$
($(L_i+ r_i)/\cancel{T}F_i$ equals to R_i and K_i for uplink and downlink, respectively.)
Bits after radio frame segmentation in the second 10 msec time interval: $(\cancel{t}k=2)$
$c_{ij} = b_{i,(j+(L_i+r_i)/\cancel{T}F_i)}$ $j=1,2, \ldots, (L_i+r_i)/\cancel{T}F_i$
…

Bits after radio frame segmentation in the $(\cancel{T}F_i-r_i)^{th}$ 10 msec time interval: $(\cancel{t}k=\cancel{T}F_i-r_i)$
$c_{ij} = b_{i,(j+(\cancel{T}F_i-r_i-1)(L_i+r_i)/\cancel{T}F_i)}$ $j=1,2, \ldots, (L_i+r_i)/\cancel{T}F_i$

Bits after radio frame segmentation in the $(\cancel{T}F_i-r_i+1)^{th}$ 10 msec time interval: $(\cancel{t}k=\cancel{T}F_i-r_i+1)$
$c_{ij} = b_{i,(j+(\cancel{T}F_i-r_i)(L_i+r_i)/\cancel{T}F_i)}$ $j=1,2, \ldots, (L_i+r_i)/\cancel{T}F_i-1$
$c_{ij} = \cancel{\text{filler\_bit}(0/1)}0$ $j= (L_i+r_i)/\cancel{T}F_i$ (filler bit)
…

Bits after radio frame segmentation in the $\cancel{T}F_i^{th}$ 10 msec time interval: $(\cancel{t}k=\cancel{T}F_i)$
$c_{ij} = b_{i,(j+(\cancel{T}F_i-1)(L_i+r_i)/\cancel{T}F_i)}$ $j=1,2, \ldots, (L_i+r_i)/\cancel{T}F_i-1$
$c_{ij} = \cancel{\text{filler\_bit}(0/1)}0$ $j=(L_i+r_i)/\cancel{T}F_i$ (filler bit)

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4.2.8. 2^{nd} Multiplexing

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~~ CCTrCH.

Figure B-1 and B-2 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 B-1 and B-2, where the notation in each data block, for examples ~~L_1, R_1,~~ K_1, N, P~~/M~~, etc., indicate number of bits of the data block.

4.2.8.1. ~~Second~~ 2nd multiplexing in uplink

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

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

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

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

...

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

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

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

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

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

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

…

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

4.2.8.2. ~~Second~~ 2nd multiplexing in downlink

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

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

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

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

…

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

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

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

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

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

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

…

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

$(K_1+K_2+\ldots+K_{N-1})+K_N$

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>

Data after 2nd multiplexing ~~of transport channels with different QoS~~ can get segmented into multiple physical channels, which are transmitted in parallel during 10ms interval.

Figure B-1 and B-2 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 B-1 and B-2, where the notation in each data block, for examples ~~L_1, R_1,~~ K_1, P, 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: $d_1, d_2, \ldots, d_P$

M is the number of physical channels

The bits after physical channel segmentation are defined by the following relationship:

The first physical channel bits after physical channel segmentation:

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

The second physical channel bits after physical channel segmentation:

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

…

The M^{th} physical channel bits after physical channel segmentation:

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

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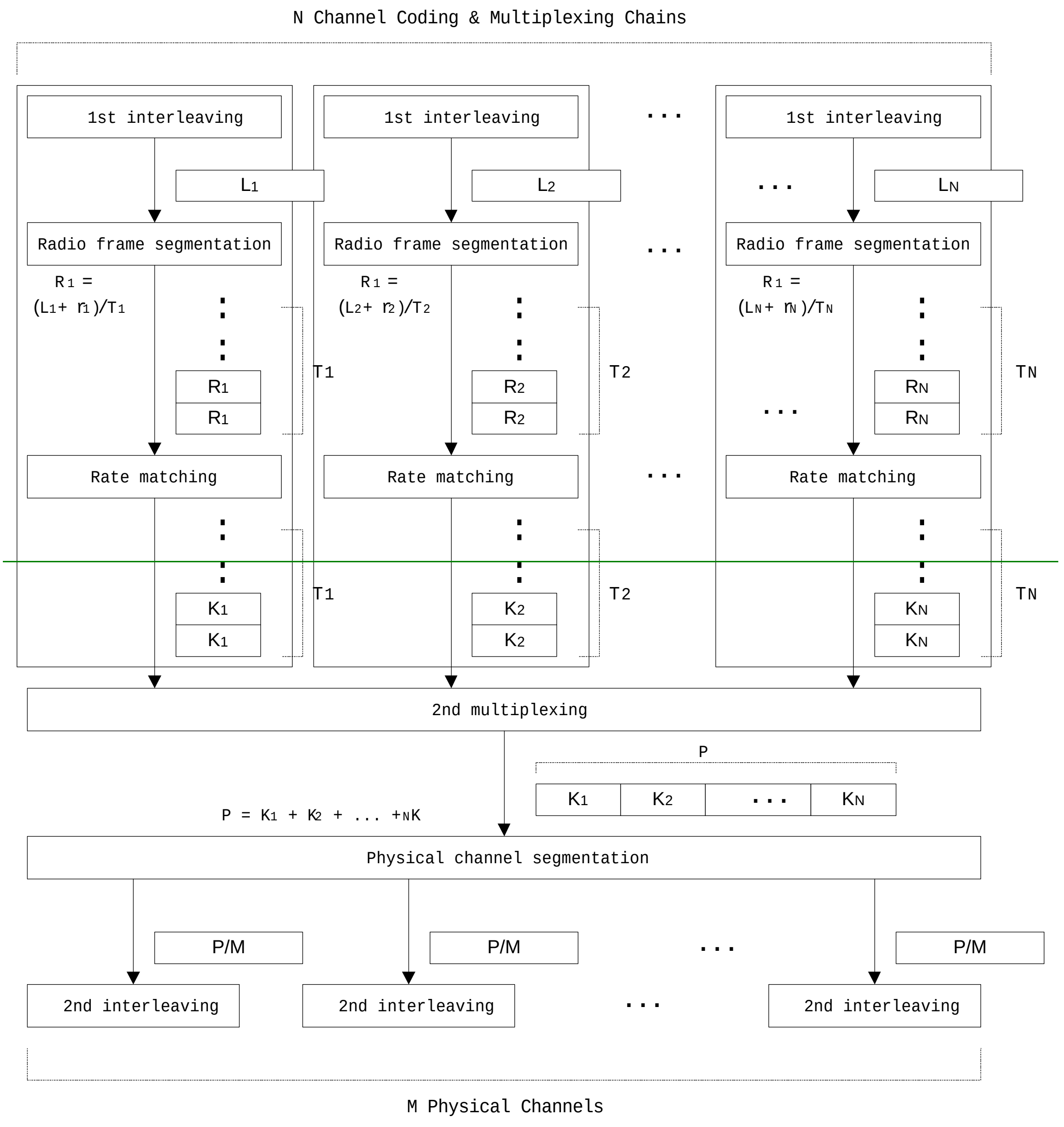
Annex B (~~informative~~normative): Data flow from radio frame segmentation to physical channel segmentation



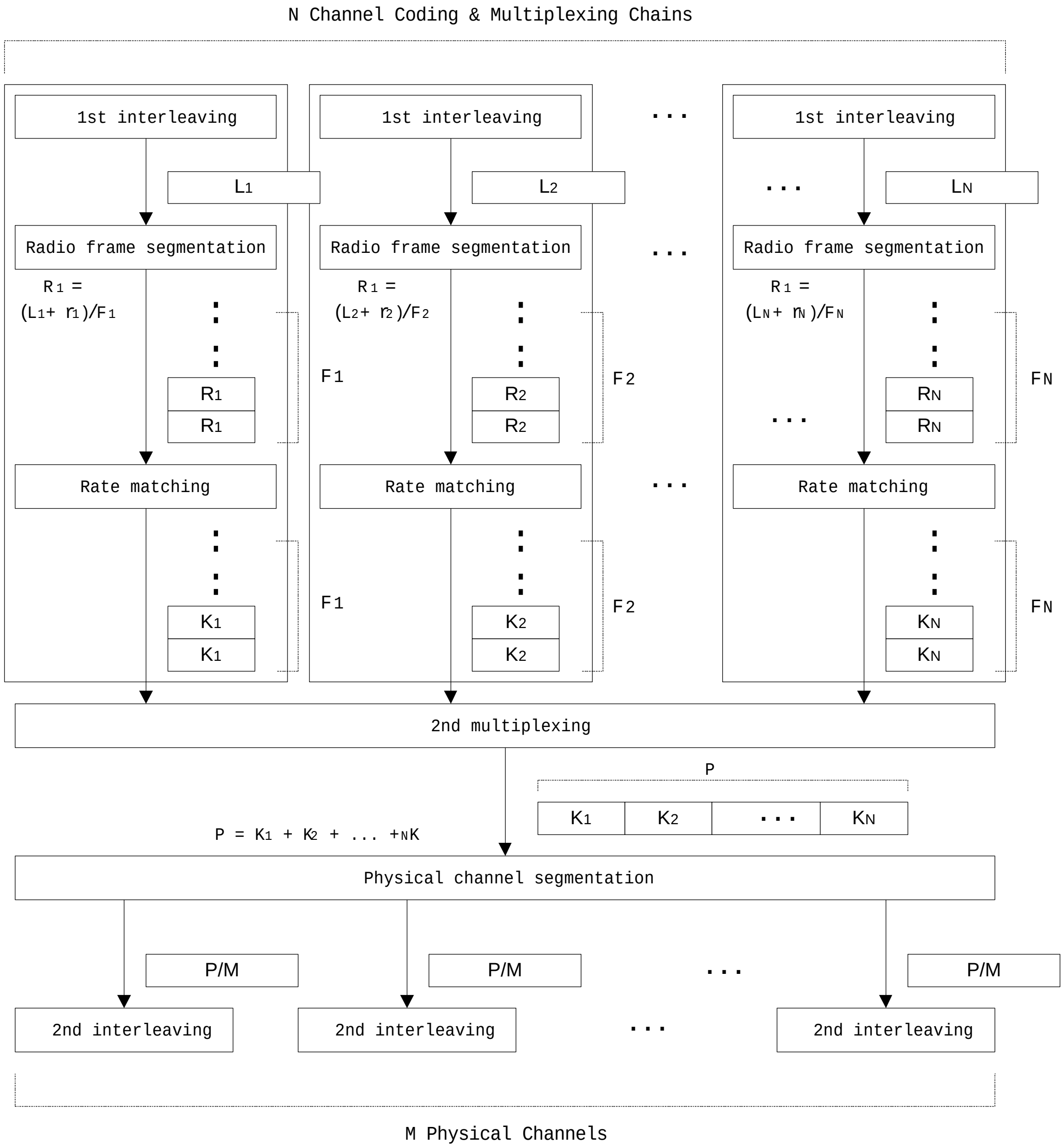
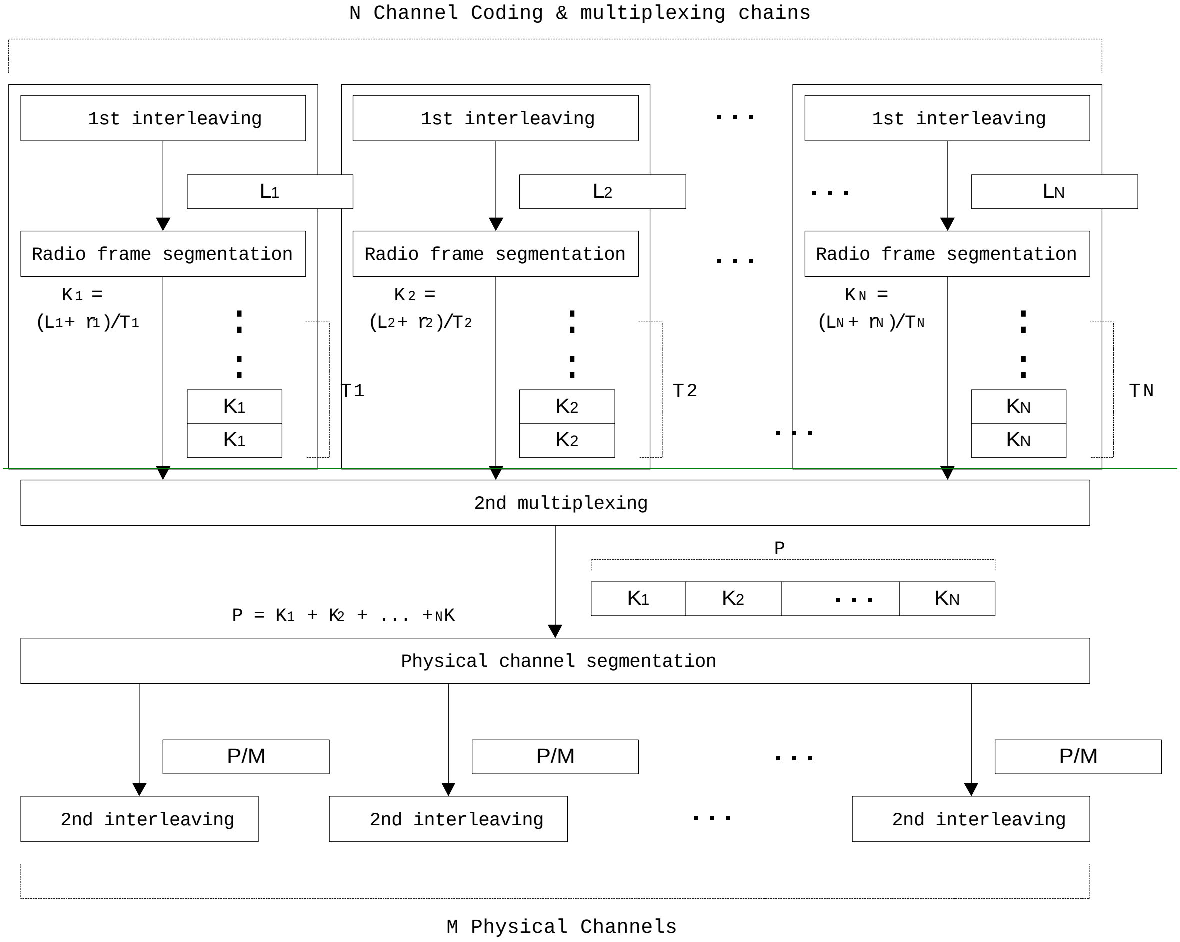


Figure B-1: Part of uplink channel coding and multiplexing chains


N Channel Coding & multiplexing chains
1st interleaving
1st interleaving
1st interleaving
L1
L2
LN
Radio frame segmentation
Radio frame segmentation
Radio frame segmentation
K1 = (L1+ r1)/T1
K2 = (L2+ r2)/T2
KN = (LN+ rN)/TN
K1
K1
K2
K2
KN
KN
T1
T2
TN
2nd multiplexing
P
K1
K2
KN
P = K1 + K2 + ... + KN
Physical channel segmentation
P/M
P/M
P/M
2nd interleaving
2nd interleaving
2nd interleaving
M Physical Channels

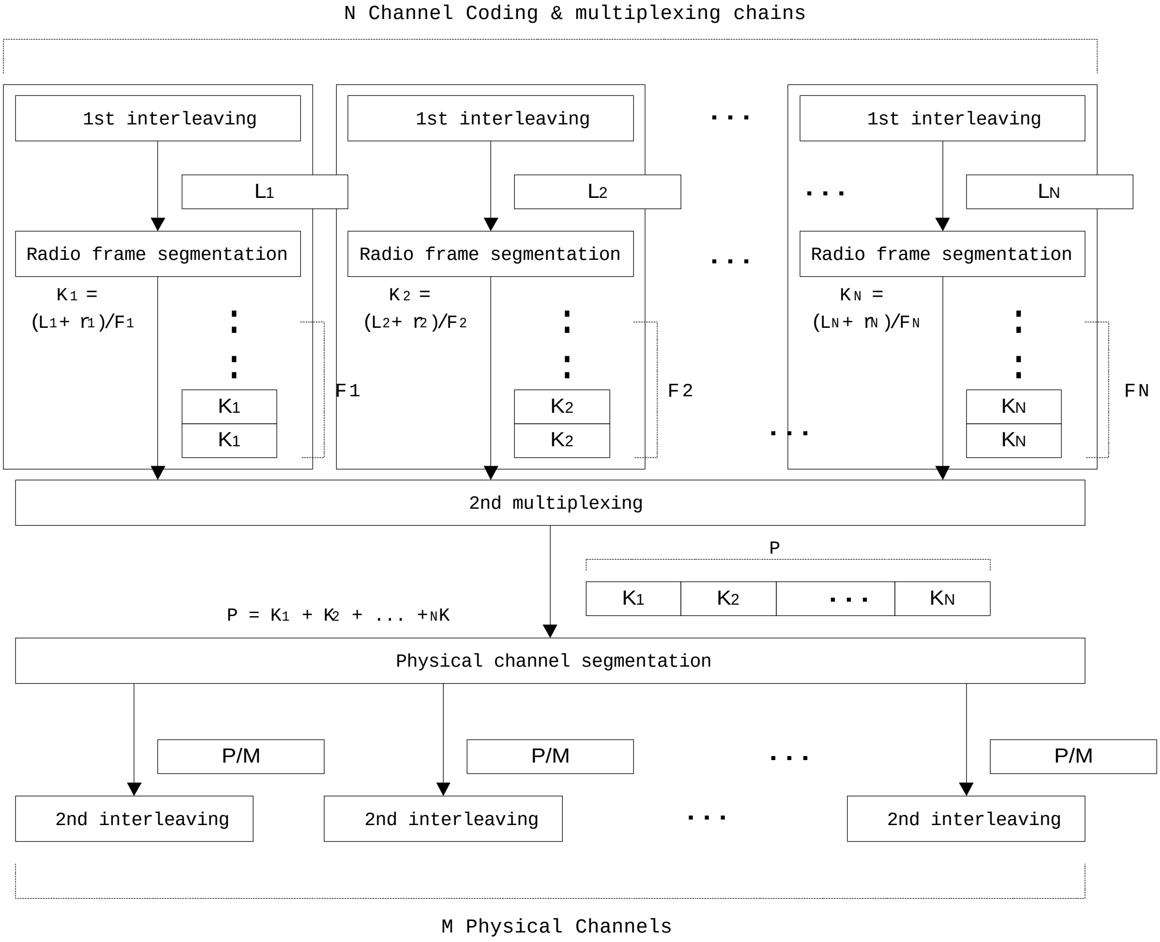


Figure B-2: Part of downlink channel coding and multiplexing chains

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2.2. Text for 25.222 (TDD)

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6.2.5. Radio frame segmentation

Each transport channel with transmission time interval 10, 20, 40, or 80 msec is segmented into 10 msec equi-sized~~ data blocks~~radio frames. Those ~~segmented ~~1, 2, 4, or 8~~ blocks~~radio frames, depending on transmission time interval, are output to rate matching in block-wise order at every 10 msec.
Figure A-1 illustrates data flow from 1st interleaver down to 2nd interleaver in channel coding and multiplexing chain. In the figures, it is assumed that there are *N* different channel coding and multiplexing chains. The following subsections describe input-output relationship of radio frame segmentation~~ in bit-wise manner~~, referring to the notation in Figure A-1, where the notations in each data block, for examples L_1, R_1, K_1, ~~*P/M,* ~~etc., indicate number of bits of the data block.

Define some notations: L_i = Size of i^{th} transport channel data in bits to radio frame segmentation

~~T~~F_i = Transmission Time Interval of i^{th} ~~channel coding and multiplexing chain ~~transport channel(msec) / 10 (msec)

So, ~~T~~F_i Î $\{1, 2, 4, 8\}$ for $i = 0, 1, 2, \ldots, N$

6.2.5.1. Radio frame size equali~~z~~sation

i^{th} transport channel data of size L_i is segmented into radio frames of size L_i/~~T~~F_i. Since the size of radio frame, L_i/~~T~~F_i is not necessarily an integer, some of ~~T~~F_i the radio frames will contain one bit less than others. For systematic process of the proceeding functional blocks, the radio frame sizes are equalized to be one finite size by considering the number of proper filler bits. Note that maximum possible filler bits are 7 for transmission time interval of 80 msec. These filler bits are evenly distributed over the one-bit short radio frames. Following is the algorithm of radio frame size equalization.

```
~~t~~ k= radio frame index (1, 2, 3, …, ~~T~~F_i) for a given i^th channel coding and multiplexing chain
r_i =( ~~T~~F_i - (L_i mod ~~T~~F_i)) mod F_i Î {0, 1, 2, …, ~~T~~F_i-1}     // number of filler bits
(L_i + r_i)/~~T~~F_i =R_i                          ______// Target radio frame size for uplink
If r_i ¹ 0 then
   For each ~~t~~ k (³ T_i-r_i+1)
   Add one filler bit to the end of ~~t~~k^th radio frame
   End
End If
```

6.2.5.2. Radio frame segmentation rule

Parameter r_i for segmentation are determined in radio frame size equalization.
The bits before radio frame segmentation for i^{th} channel coding and multiplexing chain are denoted by:
$b_{i1}, b_{i2}, \ldots b_{iL_i}$
Bits after radio frame segmentation block are 10 msec-based and denoted by:
$c_{i1}, \ldots c_{i,(L_i+r_i)/}$~~T~~$_{F_i}$
and related to the input bits to radio frame segmentation as follows.
Bits after radio frame segmentation in the first 10 msec time interval: (~~t~~$k=1$)

$c_{ij} = b_{ij}$ $j=1,2,\ldots, (L_i+r_i)/$~~T~~F_i

($(L_i + r_i)/$~~T~~F_i equals to R_i and K_i for uplink and downlink, respectively.)

Bits after radio frame segmentation in the second 10 msec time interval: (~~t~~$k=2$)

$c_{ij} = b_{i,(j+(L_i+r_i)/}$~~T~~$_{F_i)}$ $j=1,2, \ldots, (L_i+r_i)/$~~T~~$F_i$

…

Bits after radio frame segmentation in the $(\cancel{T}F_i - r_i)^{th}$ 10 msec time interval: $(\cancel{t}k = \cancel{T}F_i - r_i)$

$c_{ij} = b_{i,(j+(\cancel{T}F_i - r_i - 1)(L_i + r_i)/\cancel{T}F_i)}$ $\quad j=1,2,\ldots,(L_i+r_i)/\cancel{T}F_i$

Bits after radio frame segmentation in the $(\cancel{T}F_i - r_i + 1)^{th}$ 10 msec time interval: $(\cancel{t}k = \cancel{T}F_i - r_i + 1)$

$c_{ij} = b_{i,(j+(\cancel{T}F_i - r_i)(L_i + r_i)/\cancel{T}F_i)}$ $\quad j=1,2,\ldots,(L_i+r_i)/\cancel{T}F_i - 1$

$c_{ij} =$ ~~filler_bit(0/1)~~0 $\quad j=(L_i+r_i)/\cancel{T}F_i$ $\quad$ (filler bit)

...

Bits after radio frame segmentation in the $\cancel{T}F_i^{\text{th}}$ 10 msec time interval: $(\cancel{t}k = \cancel{T}F_i)$

$c_{ij} = b_{i,(j+(\cancel{T}F_i - 1)(L_i + r_i)/\cancel{T}F_i)}$ $\quad j=1,2,\ldots,(L_i+r_i)/\cancel{T}F_i - 1$

$c_{ij} =$ ~~filler_bit(0/1)~~0 $\quad j=(L_i+r_i)/\cancel{T}F_i$ $\quad$ (filler bit)

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6.2.7. 2nd multiplexing

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~~ CCTrCH.

Figure A-1 illustrates data flow from 1st interleaver down to 2nd interleaver in channel coding and multiplexing chain. In the figure, 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-1, where the notation in each data block, for examples ~~L_1, R_1,~~ K_1, N, P~~/M~~, etc., indicate number of bits of the data block.

~~6.2.7.1 Second multiplexing~~

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 $P=K_1+K_2+\ldots+K_N$

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

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

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

$\ldots$

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

6.2.8. Physical channel segmentation

<Editor's note: Physical channel segmentation will depend upon the QoS parameters of the different transport channels in each CCTrCH. It will be necessary to specify what are the parameters expected from L2 for it.>

<Editor's note: for physical channel segmentation, it is assumed that the segmented physical channels use the same SF>
Data after 2nd multiplexing ~~of transport channels with different QoS~~ can get segmented into multiple physical channels, which are transmitted in parallel during a 10ms interval.

Figure A-1 illustrates data flow from 1st interleaver down to 2nd interleaver in channel coding and multiplexing chain. 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 notation in Figure A-1, where the notation in each data block, for examples ~~L_1, R_1,~~ K_1, P, 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: $d_1, d_2, \ldots , d_P$
M is the number of physical channels.

The bits after physical channel segmentation are defined by the following relationship:
The first physical channel bits after physical channel segmentation:
$e_{1j} = d_j$ $j=1,2,\ldots,P/M$
The second physical channel bits after physical channel segmentation:
$e_{2j} = d_{(j+P/M)}$ $j=1,2, \ldots, P/M$
…
The M^{th} physical channel bits after physical channel segmentation:
$e_{Mj} = d_{(j+(M-1)P/M)}$ $j=1,2, \ldots, P/M$
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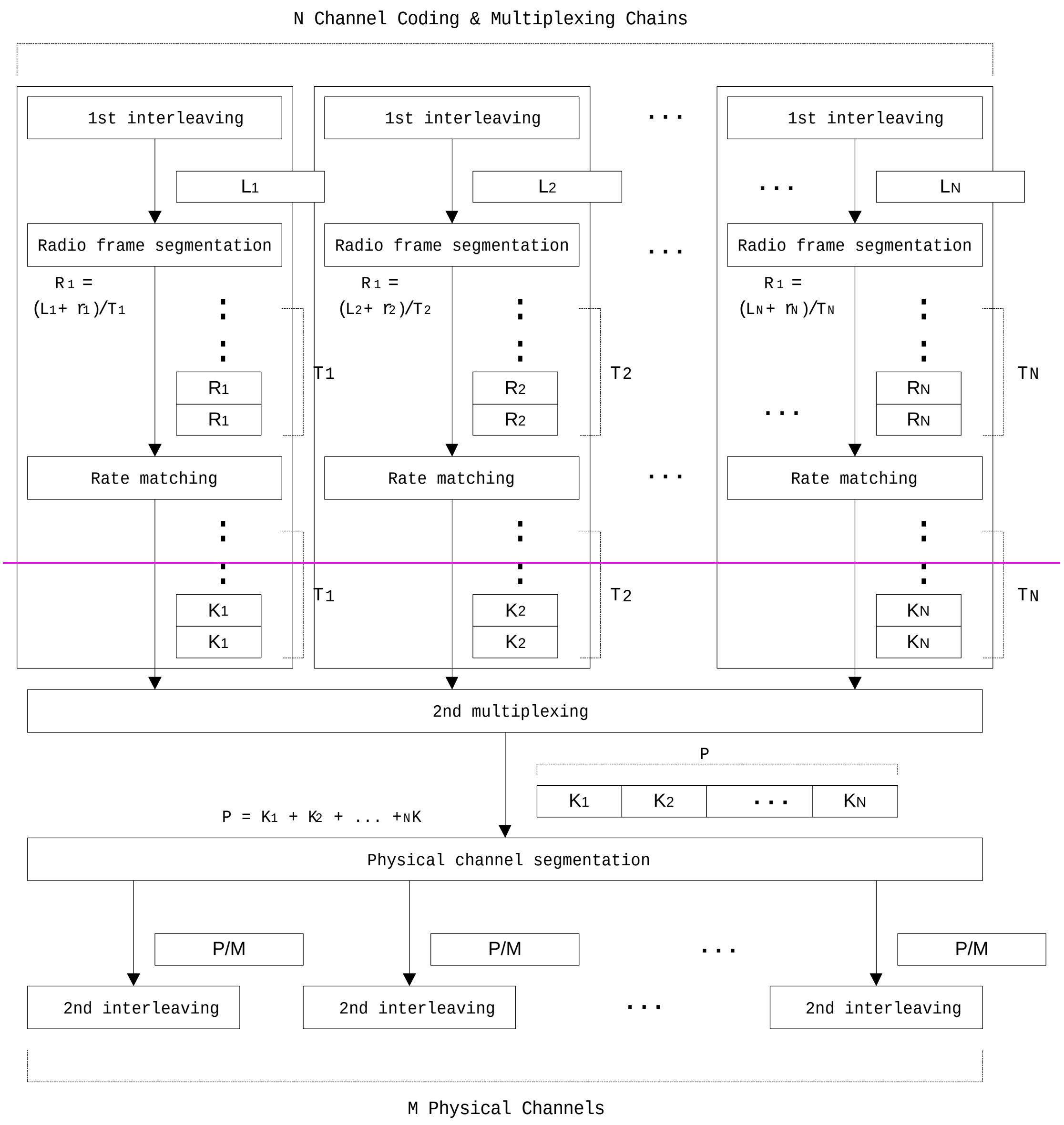
A.1 Data Flow from Radio Frame Segmentation to Physical Channel Segmentation



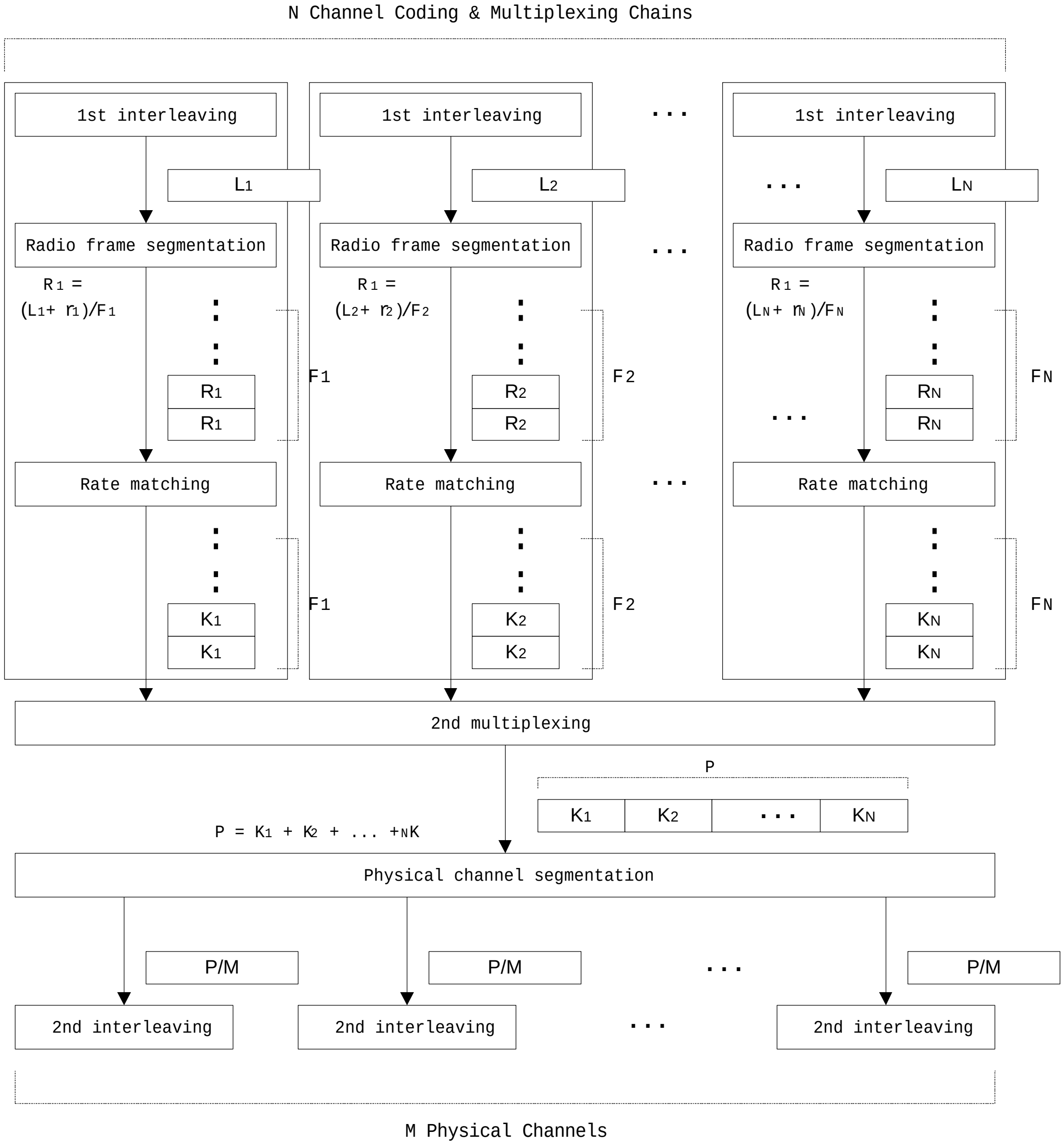


Figure A-1 Part of channel coding and multiplexing chains

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3. References

[1] TS 25.212: “Multiplexing and channel coding (FDD)”
[2] TS 25.222: “Multiplexing and channel coding (TDD)”