TSG-RAN Meeting #22 **RP-030646**
Maui, Hawaii, USA, 9 - 12 December 2003

Title: **Independent Release 4 CR to TS 25.222 and the shadow Release 5 CR**

Source: **TSG-RAN WG1**

Agenda item: **7.2.4**

RP tdoc#	WG tdoc#	Spec	CR	R	Subject	Ph	Cat	Current	New	WI	Remarks
RP-030646	R1-031277	25.222	117	1	Correction of subframe segmentation, physical channel mapping & rate matching for 1.28Mcps TDD	Rel-4	F	4.6.0	4.7.0	LCRTDD	
RP-030646	R1-031277	25.222	118	1	Correction of subframe segmentation, physical channel mapping & rate matching for 1.28Mcps TDD	Rel-5	A	5.5.0	5.6.0	LCRTDD	

3GPP TSG-RAN1 Meeting #35 ***Tdoc ⌘R1-031277***
Lisbon, Portugal, 17th – 21st November 2003

CR-Form-v7

CHANGE REQUEST

⌘	25.222	CR	117	⌘ rev	1	⌘	Current version:	4.6.0	⌘

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Proposed change affects: UICC apps⌘ [-] ME [X] Radio Access Network [X] Core Network [-]

Title:	⌘	Correction of subframe segmentation, physical channel mapping & rate matching for 1.28Mcps TDD		
Source:	⌘	TSG RAN WG1		
Work item code:	⌘	LCRTDD	***Date:*** ⌘	17/11/2003
Category:	⌘	**F**	***Release:*** ⌘	Rel-4
		Use one of the following categories: ***F*** *(correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.		*Use one of the following releases:* *2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *Rel-4 (Release 4)* *Rel-5 (Release 5)* *Rel-6 (Release 6)*

Reason for change:	⌘	The specification is incorrect in that • it indicates that a further segmentation into physical channels should take place as part of sub-frame segmentation. This leads to incorrect array sizes that would prevent the physical channel mapping from operating correctly. • It indicates that the subframe segmentation should be carried out on transport channels; it is in fact carried out on timeslots • The parameter Y_i is defined as two different quantities Furthermore, there exists a possible interpretation of rate matching for 5msec TTIs that the rate matching should be performed over a 10msec radio frame.
Summary of change:	⌘	Sub-frame segmentation has been corrected as operating on timeslots, and the final paragraph has been removed to remove the implication that a physical channel segmentation is carried out prior to the mapping. The rate matching procedure has been clarified as operating on subframes when the TTI is 5msec. Isolated Impact Analysis: Impact restricted to rate matching, sub-frame segmentation and physical channel mapping. UE or node B implementing previous version of the specification will not operate correctly. No impact on any other behaviours.
Consequences if not approved:	⌘	Erroneous behaviour in the sub-frame segmentation (basing segmentation on TrChs not timeslots, segmentation of timeslot data into physical channels when

		physical channel segmentation requires timeslot segmented data) leading to catastrophic data loss in the transmit and receive chains. Incorrect array lengths in physical channel mapping causing the specified behaviour to be not possible in an implementation.

Clauses affected:	⌘	4, 4.2.7, 4.2.7.1, 4.2.11A, 4.2.12.2, 4.2.12.2.1				
		Y	**N**			
Other specs affected:	⌘		**X**	Other core specifications	⌘	
			X	Test specifications		
			X	O&M Specifications		
Other comments:	⌘					

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1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

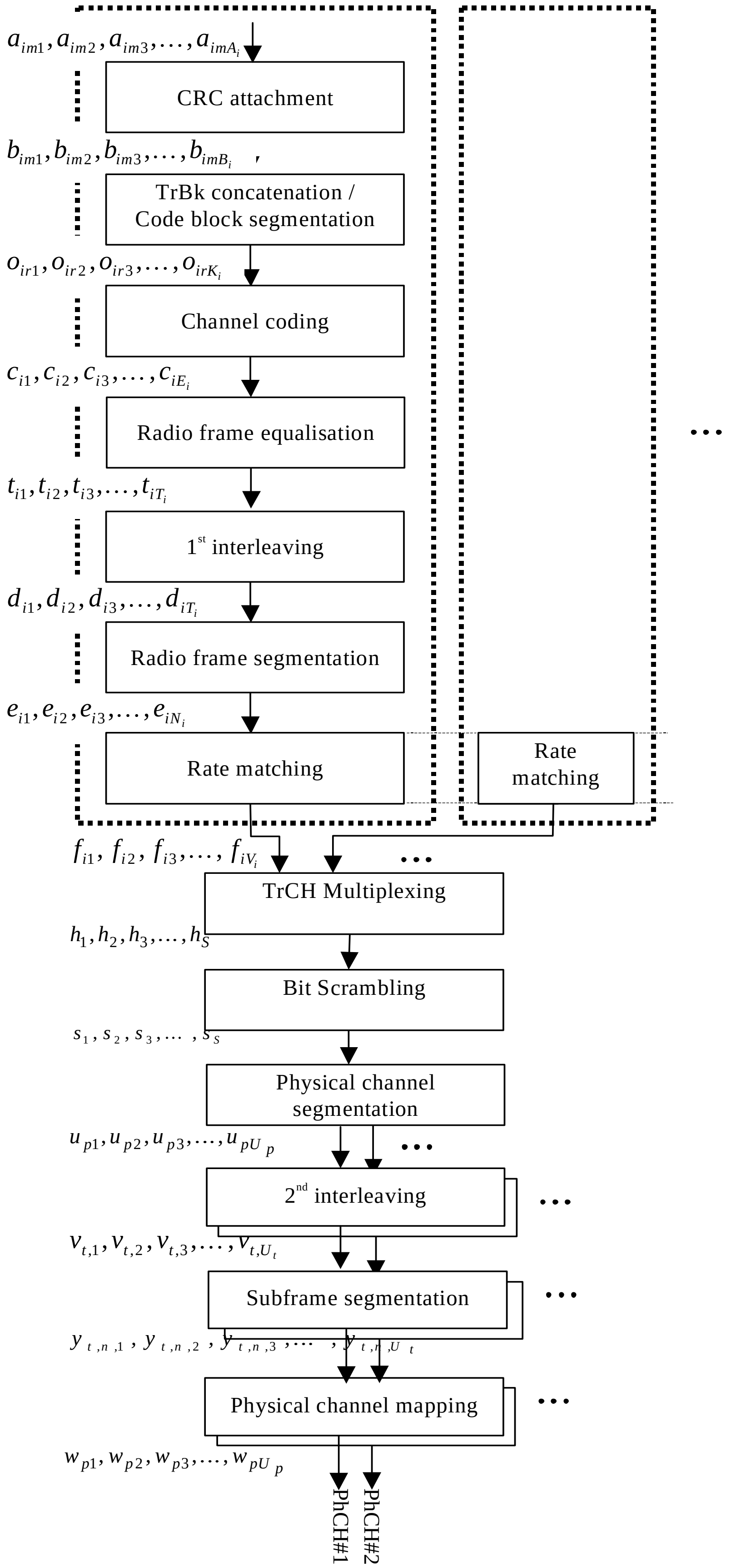

Figure 1A: Transport channel multiplexing structure for uplink and downlink of 1.28Mcps TDD

4.2.7 Rate matching

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

The number of bits on a TrCH can vary between different transmission time intervals. When the number of bits between different transmission time intervals is changed, bits are repeated to ensure that the total bit rate after TrCH multiplexing is identical to the total channel bit rate of the allocated 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.

Notation used in subclause 4.2.7 and subclauses:

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

$\Delta N_{i,j}$: If positive – number of bits to be repeated in each radio frame on TrCH *i* with transport format combination j.

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

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

PL : Puncturing limit. This value limits the amount of puncturing that can be applied in order to minimise the number of physical channels. 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 a CCTrCH in a radio frame with transport format combination j.

P : number of physical channels used in the current frame.

P_{max} : maximum number of physical channels allocated for a CCTrCH.

U_p : Number of data bits in the physical channel p with p = 1...P during a radio frame.

I : Number of TrCHs in a 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* ($0 \leq n_i < F_i$).

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

$P1_F(n_i)$: 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 (note that $P1_F$ self-inverse).

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

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

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

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

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

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

b : Indicates systematic and parity bits.

b=1: Systematic bit. $X(t)$ in subclause 4.2.3.2.1.

b=2: 1st parity bit (from the upper Turbo constituent encoder). $Y(t)$ in subclause 4.2.3.2.1.

b=3: 2nd parity bit (from the lower Turbo constituent encoder). $Y'(t)$ in subclause 4.2.3.2.1.

Note: when the TTI is 5msec for 1.28Mcps, the above notation refers to a sub-frame rather than a radio frame. In this case, $F_i = 1$ and $n_i = 0$.

4.2.7.1 Determination of rate matching parameters

The following relations, defined for all TFC j, are used when calculating the rate matching pattern:

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

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

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

Puncturing can be used to minimise the required transmission capacity. The maximum amount of puncturing that can be applied is 1-PL, PL is signalled from higher layers. The possible values for N_{data} depend on the number of physical channels P_{max}, allocated to the respective CCTrCH, and on their characteristics (spreading factor, length of midamble and TFCI code word, usage of TPC and multiframe structure), which is given in [7].

For each physical channel an individual minimum spreading factor Sp_{min} is transmitted by means of the higher layers. Denote the number of data bits in each physical channel by $U_{p,Sp}$, where p indicates the sequence number $1 \le p \le P_{max}$ and Sp indicates the spreading factor with the possible values {16, 8, 4, 2, 1} of this physical channel. The index p is described in section 4.2.12 with the following modifications: spreading factor (Q) is replaced by the minimum spreading factor Sp_{min} and k is replaced by the channelization code index at $Q= Sp_{min}$. Then, for N_{data} one of the following values in ascending order can be chosen:

$$\left\{U_{1,S1_{min}}, U_{1,S1_{min}} + U_{2,S2_{min}}, U_{1,S1_{min}} + U_{2,S2_{min}} + \ldots + U_{P_{max},(SP_{max})_{min}}\right\}$$

Optionally, if indicated by higher layers for the UL the UE shall vary the spreading factor autonomously, so that N_{data} is one of the following values in ascending order:

$$\left\{U_{1,16}, \ldots, U_{1,S1_{min}}, U_{1,S1_{min}} + U_{2,16}, \ldots, U_{1,S1_{min}} + U_{2,S2_{min}}, \ldots, U_{1,S1_{min}} + U_{2,S2_{min}} + \ldots + U_{P_{max},16}, \ldots, U_{1,S1_{min}} + U_{2,S2_{min}} + \ldots + U_{P_{max},(SP_{max})_{min}}\right\}$$

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

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

$N_{data,j}$ = min SET1

The number of bits to be repeated or punctured, $\Delta N_{i,j}$, within one radio frame (one sub-frame when the TTI is 5msec) for each TrCH i is calculated with the relations given at the beginning of this subclause for all possible transport format combinations j and selected every radio frame (sub-frame). The number of physical channels corresponding to $N_{data,j}$, shall be denoted by P.

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 4.2.7.3 does not need to be executed.

Otherwise, the rate matching pattern is calculated with the algorithm described in subclause 4.2.7.3. For this algorithm the parameters e_{ini}, e_{plus}, e_{minus}, and X_i are needed, which are calculated according to the equations in subclauses 4.2.7.1.1 and 4.2.7.1.2.

4.2.11A Sub-frame segmentation for the 1.28 Mcps option

In the 1.28Mcps TDD, it is needed to add a sub-frame segmentation unit between 2nd interleaving unit and physical channel mapping unit when the TTI of the CCTrCh is greater than 5msec. ~~T~~In this case, the operation of rate-matching guarantees that the size of bit streams is an even number and can be subdivided into 2 sub-frames. The transport channel multiplexing structure for uplink and downlink is shown in figure 1A.

The input to the sub-frame segmentation unit is segmented into timeslot chunks, where each timeslot chunk contains all of the bits that are to be transmitted in a given timeslot position in both of the sub-frames.

The input bit sequence is denoted by $x_{i1}, x_{i2}, x_{i3}, \ldots, x_{iX_i}$ where i is the ~~TrCH~~ timeslot number and X_i is the number of bits transmitted in timeslot i in each sub-frame. The two output bit sequences per radio frame are denoted by ~~$y_{i,n_i1}, y_{i,n_i2}, y_{i,n_i3}, \ldots, y_{i,n_iY_i}$~~ $y_{i,n,1}, y_{i,n,2}, y_{i,n,3}, \ldots, y_{i,n,Y_i}$ where n~~ni~~ is the sub-frame number in current radio frame and Y_i is the number of bits per ~~radio~~ sub frame for ~~TrCH~~ timeslot i. The output sequences are defined as follows:

$y_{i,n,k}$ ~~y_{i,n_ik}~~ = $x_{i,((n-1).Y_i)+k}$ ~~$x_{i,((n_i-1)Y_i)+k}$~~, n~~$_i$~~ = 1 or 2, k = 1…Y_i

where

$Y_i = (X_i / 2)$ is the number of bits in timeslot i per sub-frame,

x_{ik} is the k^th bit of the input bit sequence and

$y_{i,n,k}$ ~~y_{i,n_ik}~~ is the k^th bit of the output bit sequence corresponding to the n^th sub-frame

~~The input bit sequence to the sub-frame segmentation is denoted by $v_{t,1}, v_{t,2}, v_{t,3}, \ldots, v_{t,U_t}$, $x_{ik} = v_{t,k}$ and $X_i = U_t$.~~

~~The output bit sequence corresponding to subframe n_i is denoted by $g_{p1}, g_{p2}, \ldots, g_{pU_p}$, where p is the PhCH number and U_p is the number of bits in one subframe for the respective PhCH. Hence, $g_{pk} = y_{i,n_ik}$ and $U_p = Y_i$.~~

4.2.12.2 Physical channel mapping for the 1.28 Mcps option

The bit streams from the sub-frame segmentation unit are mapped onto code channels of time slots in sub-frames.

The bits after physical channel mapping are denoted by $w_{p1}, w_{p2}, \ldots, w_{pU_p}$, where p is the PhCH number and Up is the number of bits in one sub-frame for the respective PhCH. The bits wpk are mapped to the PhCHs so that the bits for each PhCH are transmitted over the air in ascending order with respect to k.

The mapping of the bits ~~$g_{p1}, g_{p2}, \ldots, g_{pU_p}$~~ $y_{t,n,1}, y_{t,n,2}, y_{t,n,3}, \ldots, y_{t,n,Ut}$ is performed like block interleaving, writing the bits into columns, but a PhCH with an odd number is filled in forward order, were as a PhCH with an even number is filled in reverse order.

The mapping scheme, as described in the following subclause, shall be applied individually for each timeslot t used in the current subframe. Therefore, the bits $y_{t,n,1}, y_{t,n,2}, y_{t,n,3}, \ldots, y_{t,n,Ut}$ ~~$g_{p1}, g_{p2}, \ldots, g_{pU_p}$~~ are assigned to the bits of the physical channels $w_{t1,1\ldots U_{t1}}, w_{t2,1\ldots U_{t2}}, \ldots, w_{tP_t,1\ldots U_{tP_t}}$ in each timeslot.

In uplink there are at most two codes allocated (P≤2). If there is only one code, the same mapping as for downlink is applied. Denote SF1 and SF2 the spreading factors used for code 1 and 2, respectively. For the number of consecutive bits to assign per code bsk the following rule is applied:

if

SF1 >= SF2 then bs_1 = 1 ; bs_2 = SF1/SF2 ;

else

SF2 > SF1 then bs_1 = SF2/SF1; bs_2 = 1 ;

end if

In the downlink case bs_p is 1 for all physical channels.

4.2.12.2.1 Mapping scheme

Notation used in this subclause:

P_t: number of physical channels for timeslot t , P_t = 1..2 for uplink ; P_t = 1...16 for downlink

U_{tp}: capacity in bits for the physical channel p in timeslot t in the current sub-frame

U_t.: total number of bits to be assigned for timeslot t in the current sub-frame

n = index of the current sub-frame (1 or 2)

bs_p: number of consecutive bits to assign per code

for downlink all $bs_p = 1$

for uplink if SF1 >= SF2 then $bs_1 = 1$; bs_2 = SF1/SF2 ;

if SF2 > SF1 then bs_1 = SF2/SF1; $bs_2 = 1$;

fb_p: number of already written bits for each code

pos: intermediate calculation variable

for p=1 to P_t -- reset number of already written bits for every physical channel

$fb_p = 0$

end for

p = 1 -- start with PhCH #1

for k=1 to U_t.

do while ($fb_p == U_{t,p}$) -- physical channel filled up already ?

p = (p mod P_t) + 1 ;

end do

if (p mod 2) == 0

pos = $U_{t,p} - fb_p$ -- reverse order

else

pos = $fb_p + 1$ -- forward order

end if

$w_{tp,pos}$ = ~~$g_{t,k}$~~ $y_{t,n,k}$ -- assignment

$fb_p = fb_p + 1$ -- Increment number of already written bits

If (fb_p mod bs_p) == 0 -- Conditional change to the next physical channel

p = (p mod P t) + 1 ;

end if

end for

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Reason for change: ⌘ The specification is incorrect in that

- it indicates that a further segmentation into physical channels should take place as part of sub-frame segmentation. This leads to incorrect array sizes that would prevent the physical channel mapping from operating correctly.
- It indicates that the subframe segmentation should be carried out on transport channels; it is in fact carried out on timeslots
- The parameter Y_i is defined as two different quantities
- Furthermore, there exists a possible interpretation of rate matching for 5msec TTIs that the rate matching should be performed over a 10msec radio frame.

Summary of change: ⌘

Sub-frame segmentation has been corrected as operating on timeslots, and the final paragraph has been removed to remove the implication that a physical channel segmentation is carried out prior to the mapping.

The rate matching procedure has been clarified as operating on subframes when the TTI is 5msec.

Isolated Impact Analysis:
Impact restricted to rate matching, sub-frame segmentation and physical channel mapping. UE or node B implementing previous version of the specification will not operate correctly. No impact on any other behaviours.

Consequences if ⌘ Erroneous behaviour in the sub-frame segmentation (basing segmentation on

not approved:	TrChs not timeslots, segmentation of timeslot data into physical channels when physical channel segmentation requires timeslot segmented data) leading to catastrophic data loss in the transmit and receive chains. Incorrect array lengths in physical channel mapping causing the specified behaviour to be not possible in an implementation.

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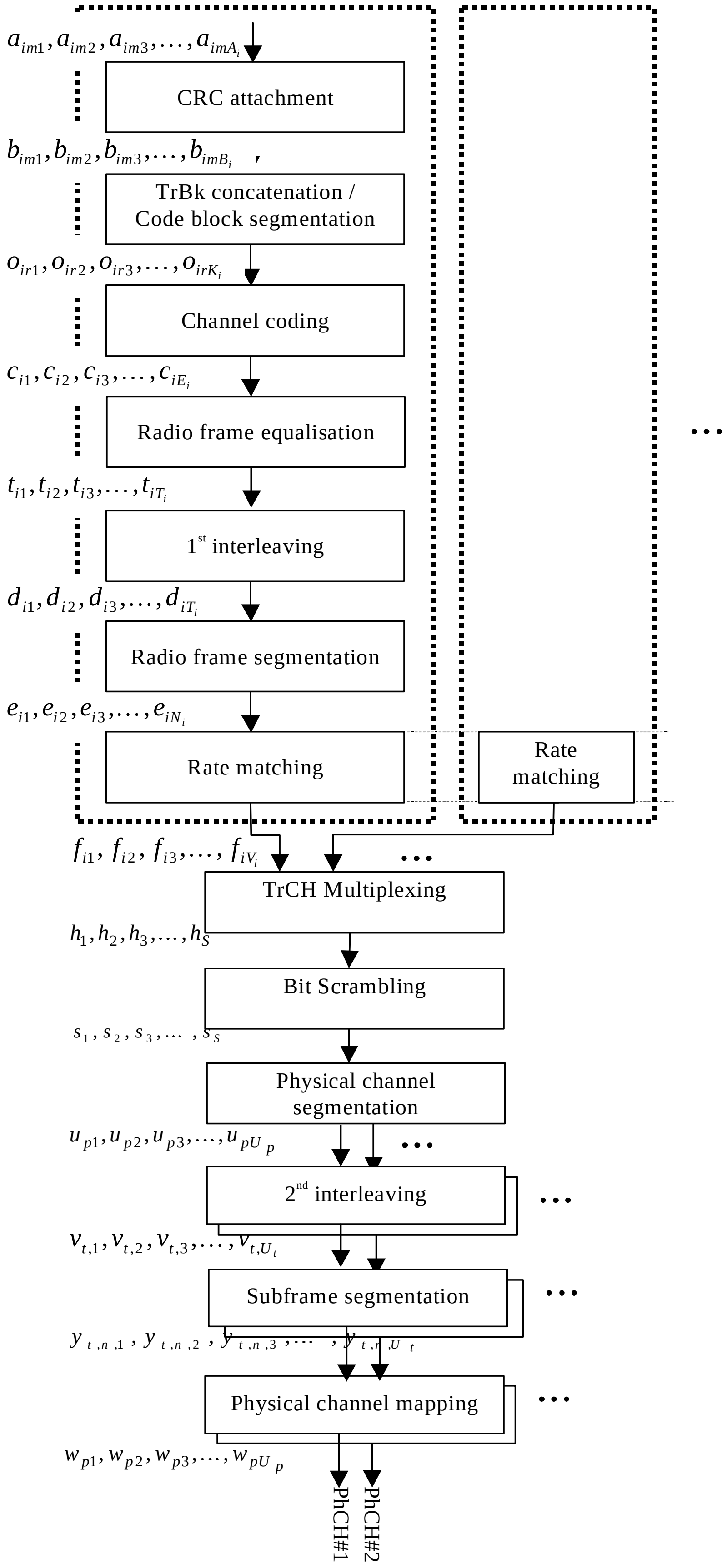

Figure 1A: Transport channel multiplexing structure for uplink and downlink of 1.28Mcps TDD

4.2.7 Rate matching

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

The number of bits on a TrCH can vary between different transmission time intervals. When the number of bits between different transmission time intervals is changed, bits are repeated to ensure that the total bit rate after TrCH multiplexing is identical to the total channel bit rate of the allocated physical channels.

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

PL : Puncturing limit. This value limits the amount of puncturing that can be applied in order to minimise the number of physical channels. 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 a CCTrCH in a radio frame with transport format combination j.

P : number of physical channels used in the current frame.

P_{max} : maximum number of physical channels allocated for a CCTrCH.

U_p : Number of data bits in the physical channel p with p = 1...P during a radio frame.

I : Number of TrCHs in a 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* ($0 \le n_i < F_i$).

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

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

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b=1: Systematic bit. *X(t)* in subclause 4.2.3.2.1.

b=2: 1st parity bit (from the upper Turbo constituent encoder). *Y(t)* in subclause 4.2.3.2.1.

b=3: 2nd parity bit (from the lower Turbo constituent encoder). *Y'(t)* in subclause 4.2.3.2.1.

Note: when the TTI is 5msec for 1.28Mcps, the above notation refers to a sub-frame rather than a radio frame. In this case, $F_i = 1$ and $n_i = 0$.

4.2.7.1 Determination of rate matching parameters

The following relations, defined for all TFC *j*, are used when calculating the rate matching pattern:

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

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

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

Puncturing can be used to minimise the required transmission capacity. The maximum amount of puncturing that can be applied is 1-PL, PL is signalled from higher layers. The possible values for N_{data} depend on the number of physical channels P_{max}, allocated to the respective CCTrCH, and on their characteristics (spreading factor, length of midamble and TFCI code word, usage of TPC and multiframe structure), which is given in [7].

For each physical channel an individual minimum spreading factor Sp_{min} is transmitted by means of the higher layers. Denote the number of data bits in each physical channel by $U_{p,Sp}$, where *p* indicates the sequence number $1 \le p \le P_{max}$ and *Sp* indicates the spreading factor with the possible values {*16, 8, 4, 2, 1*} of this physical channel. The index *p* is described in section 4.2.12 with the following modifications: spreading factor (*Q*) is replaced by the minimum spreading factor Sp_{min} and *k* is replaced by the channelization code index at $Q = Sp_{min}$. Then, for N_{data} one of the following values in ascending order can be chosen:

$$\left\{U_{1,S1_{\min}}, U_{1,S1_{\min}} + U_{2,S2_{\min}}, U_{1,S1_{\min}} + U_{2,S2_{\min}} + \ldots + U_{P_{\max},(SP_{\max})_{\min}}\right\}$$

Optionally, if indicated by higher layers for the UL the UE shall vary the spreading factor autonomously, so that N_{data} is one of the following values in ascending order:

$$\left\{U_{1,16}, \ldots, U_{1,S1_{\min}}, U_{1,S1_{\min}} + U_{2,16}, \ldots, U_{1,S1_{\min}} + U_{2,S2_{\min}}, \ldots, U_{1,S1_{\min}} + U_{2,S2_{\min}} + \ldots + U_{P_{\max},16}, \ldots, U_{1,S1_{\min}} + U_{2,S2_{\min}} + \ldots + U_{P_{\max},(SP_{\max})_{\min}}\right\}$$

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

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

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

The number of bits to be repeated or punctured, $\Delta N_{i,j}$, within one radio frame (one sub-frame when the TTI is 5msec) for each TrCH i is calculated with the relations given at the beginning of this subclause for all possible transport format combinations j and selected every radio frame (sub-frame). The number of physical channels corresponding to $N_{data,\, j}$, shall be denoted by P.

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 4.2.7.3 does not need to be executed.

Otherwise, the rate matching pattern is calculated with the algorithm described in subclause 4.2.7.3. For this algorithm the parameters e_{ini}, e_{plus}, e_{minus}, and X_i are needed, which are calculated according to the equations in subclauses 4.2.7.1.1 and 4.2.7.1.2.

4.2.11A Sub-frame segmentation for the 1.28 Mcps option

In the 1.28Mcps TDD, it is needed to add a sub-frame segmentation unit between 2nd interleaving unit and physical channel mapping unit when the TTI of the CCTrCh is greater than 5msec. TIn this case, the operation of rate-matching guarantees that the size of bit streams is an even number and can be subdivided into 2 sub-frames. The transport channel multiplexing structure for uplink and downlink is shown in figure 1A.

The input to the sub-frame segmentation unit is segmented into timeslot chunks, where each timeslot chunk contains all of the bits that are to be transmitted in a given timeslot position in both of the sub-frames.

The input bit sequence is denoted by $x_{i1}, x_{i2}, x_{i3}, \ldots, x_{iX_i}$ where i is the TrCH timeslot number and X_i is the number of bits transmitted in timeslot i in each sub-frame. The two output bit sequences per radio frame are denoted by $y_{i,n_i 1}, y_{i,n_i 2}, y_{i,n_i 3}, \ldots, y_{i,n_i Y_i}$ $y_{i,n,1}, y_{i,n,2}, y_{i,n,3}, \ldots, y_{i,n,Yi}$ where n_i ni is the sub-frame number in current radio frame and Y_i is the number of bits per radio sub frame for TrCH timeslot i. The output sequences are defined as follows:

$$y_{i,n,k} \; y_{i,n_i k} = x_{i,((n-1).Y_i)+k} \; x_{i,((n_i-1)Y_i)+k}, \quad n_i = 1 \text{ or } 2,\ k = 1 \ldots Y_i$$

where

$Y_i = (X_i / 2)$ is the number of bits in timeslot i per sub-frame,

x_{ik} is the k^th bit of the input bit sequence and

$y_{i,n,k}$ $y_{i,n_i k}$ is the k^th bit of the output bit sequence corresponding to the n^th sub-frame

The input bit sequence to the sub-frame segmentation is denoted by $v_{t,1}, v_{t,2}, v_{t,3}, \ldots, v_{t,U_t}$, $x_{ik} = v_{t,k}$ and $X_i = U_t$.

The output bit sequence corresponding to subframe n_i is denoted by $g_{p1}, g_{p2}, \ldots, g_{pU_p}$, where p is the PhCH number and U_p is the number of bits in one subframe for the respective PhCH. Hence, $g_{pk} = y_{i,n_i k}$ and $U_p = Y_i$.

4.2.12.2 Physical channel mapping for the 1.28 Mcps option

The bit streams from the sub-frame segmentation unit are mapped onto code channels of time slots in sub-frames.

The bits after physical channel mapping are denoted by $w_{p1}, w_{p2}, \ldots, w_{pU_p}$, where p is the PhCH number and Up is the number of bits in one sub-frame for the respective PhCH. The bits wpk are mapped to the PhCHs so that the bits for each PhCH are transmitted over the air in ascending order with respect to k.

The mapping of the bits ~~$g_{p1}, g_{p2}, \ldots, g_{pU_p}$~~ $y_{t,n,1}, y_{t,n,2}, y_{t,n,3}, \ldots, y_{t,n,Ut}$ is performed like block interleaving, writing the bits into columns, but a PhCH with an odd number is filled in forward order, were as a PhCH with an even number is filled in reverse order.

The mapping scheme, as described in the following subclause, shall be applied individually for each timeslot t used in the current subframe. Therefore, the bits $y_{t,n,1}, y_{t,n,2}, y_{t,n,3}, \ldots, y_{t,n,Ut}$ ~~$g_{p1}, g_{p2}, \ldots, g_{pU_p}$~~ are assigned to the bits of the physical channels $w_{t1,1\ldots U_{t1}}, w_{t2,1\ldots U_{t2}}, \ldots, w_{tP_t,1\ldots U_{tP_t}}$ in each timeslot.

In uplink there are at most two codes allocated (P≤2). If there is only one code, the same mapping as for downlink is applied. Denote SF1 and SF2 the spreading factors used for code 1 and 2, respectively. For the number of consecutive bits to assign per code bsk the following rule is applied:

if

SF1 >= SF2 then $bs_1 = 1$; $bs_2 =$ SF1/SF2 ;

else

SF2 > SF1 then $bs_1 =$ SF2/SF1; $bs_2 = 1$;

end if

In the downlink case bs_p is 1 for all physical channels.

4.2.12.2.1 Mapping scheme

Notation used in this subclause:

P_t: number of physical channels for timeslot t , P_t = 1..2 for uplink ; P_t = 1...16 for downlink

U_{tp}: capacity in bits for the physical channel p in timeslot t in the current sub-frame

U_t.: total number of bits to be assigned for timeslot t in the current sub-frame

n = index of the current sub-frame (1 or 2)

bs_p: number of consecutive bits to assign per code

for downlink all $bs_p = 1$

for uplink if SF1 >= SF2 then $bs_1 = 1$; bs_2 = SF1/SF2 ;

if SF2 > SF1 then bs_1 = SF2/SF1; $bs_2 = 1$;

fb_p: number of already written bits for each code

pos: intermediate calculation variable

```
for p=1 to P t            -- reset number of already written bits for every physical channel
fbp = 0
end for
p = 1                     -- start with PhCH #1
for k=1 to Ut.
do while (fbp == Ut,p)    -- physical channel filled up already ?
p = (p mod P t) + 1 ;
end do
if (p mod 2) == 0
pos = Ut,p - fbp          -- reverse order
else
pos = fbp + 1             -- forward order
end if
wtp,pos = gt,k yt,n,k     -- assignment
fbp = fbp + 1             -- Increment number of already written bits
If (fbp mod bsp) == 0     -- Conditional change to the next physical channel
p = (p mod P t) + 1 ;
end if
end for
```