TSG RAN Meeting #28 **RP-050249**
Quebec, Canada, 1 - 3 June 2005

Title **CRs (Rel-5 & Rel-6 category) to TS25.211, TS25.212, TS25.214 & TS25.215 for Feature clean up: Removal of the 'compressed mode by puncturing'**
Source **TSG RAN WG1**
Agenda Item **7.7.8**

RAN1 Tdoc	Spec	CR	Rev	Rel	Cat	Current Version	Subject	Work item	Remarks
R1-050525	25.211	218	-	Rel-5	C	5.6.0	Feature clean up: Removal of the 'compressed mode by puncturing'	TEI5	
R1-050525	25.211	219	-	Rel-6	C	6.4.0	Feature clean up: Removal of the 'compressed mode by puncturing'	TEI6	
R1-050525	25.212	213	1	Rel-5	C	5.9.0	Feature clean up: Removal of the 'compressed mode by puncturing'	TEI5	
R1-050525	25.212	218	1	Rel-6	C	6.4.0	Feature clean up: Removal of the 'compressed mode by puncturing'	TEI6	
R1-050525	25.214	388	-	Rel-5	C	5.10.0	Feature clean up: Removal of the 'compressed mode by puncturing'	TEI5	
R1-050525	25.214	389	-	Rel-6	C	6.5.0	Feature clean up: Removal of the 'compressed mode by puncturing'	TEI6	
R1-050525	25.215	164	-	Rel-5	C	5.6.0	Feature clean up: Removal of the 'compressed mode by puncturing'	TEI5	
R1-050525	25.215	165	-	Rel-6	C	6.2.0	Feature clean up: Removal of the 'compressed mode by puncturing'	TEI6	

3GPP TSG RAN WG1 Meeting #41
Athens, Greece, May 9-13, 2005

Tdoc ⌘R1-050525

CR-Form-v7.1

CHANGE REQUEST

⌘	25.211	CR	218	⌘rev	-	⌘	Current version:	5.6.0	⌘

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

Title:	⌘	Feature clean up: Removal of the 'compressed mode by puncturing'
Source:	⌘	RAN WG1
Work item code:	⌘	TEI5
Date:	⌘	18/04/2005
Category:	⌘	C
Release:	⌘	Rel-5

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:
- *Ph2 (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)*
- *Rel-7 (Release 7)*

Reason for change:	⌘	The feature 'compressed mode by puncturing' is not used in real networks. Furthermore, as compressed mode by puncturing is only applicable for fixed positions in DL, it not expected to be the best way of handling compressed mode measurements with future services. RAN #27 decided with RP-050144 to remove this feature.
Summary of change:	⌘	The method for generating the downlink compressed mode gap by puncturing is removed.
Consequences if not approved:	⌘	Simplification of specifications, reduction of complexity and easier evolution chance would be missed and a RAN #27 decision would be violated.

Clauses affected:	⌘	5.3.2				
		Y	**N**			
Other specs affected:	⌘	X		Other core specifications	⌘	25.101, 25.133, 25.212, 25.214, 25.215, 25.331, 25.423, 25.433
				Test specifications		
			X	O&M Specifications		
Other comments:	⌘	Contents of this CR is unchanged compared to R1-050479.				

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5.3.2 Dedicated downlink physical channels

There is only one type of downlink dedicated physical channel, the Downlink Dedicated Physical Channel (downlink DPCH).

Within one downlink DPCH, dedicated data generated at Layer 2 and above, i.e. the dedicated transport channel (DCH), is transmitted in time-multiplex with control information generated at Layer 1 (known pilot bits, TPC commands, and an optional TFCI). The downlink DPCH can thus be seen as a time multiplex of a downlink DPDCH and a downlink DPCCH, compare subclause 5.2.1.

Figure 9 shows the frame structure of the downlink DPCH. Each frame of length 10 ms is split into 15 slots, each of length T_{slot} = 2560 chips, corresponding to one power-control period.

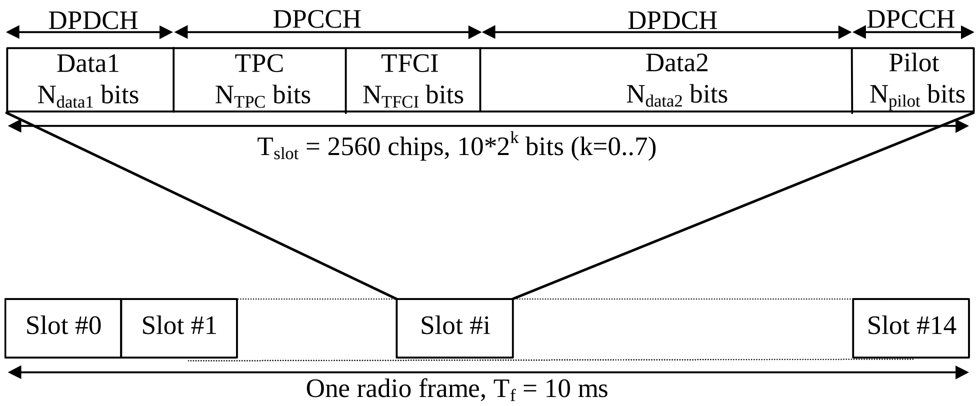

Figure 9: Frame structure for downlink DPCH

The parameter k in figure 9 determines the total number of bits per downlink DPCH slot. It is related to the spreading factor SF of the physical channel as SF = $512/2^k$. The spreading factor may thus range from 512 down to 4.

The exact number of bits of the different downlink DPCH fields (N_{pilot}, N_{TPC}, N_{TFCI}, N_{data1} and N_{data2}) is given in table 11. What slot format to use is configured by higher layers and can also be reconfigured by higher layers.

There are basically two types of downlink Dedicated Physical Channels; those that include TFCI (e.g. for several simultaneous services) and those that do not include TFCI (e.g. for fixed-rate services). These types are reflected by the duplicated rows of table 11. It is the UTRAN that determines if a TFCI should be transmitted and it is mandatory for all UEs to support the use of TFCI in the downlink. The mapping of TFCI bits onto slots is described in [3].

In compressed frames, a different slot format is used compared to normal mode. There are two possible compressed slot formats that are labelled A and B. Slot format B shall be used in frames compressed by spreading factor reduction and slot format A shall be used in frames compressed by ~~puncturing or~~ higher layer scheduling. The channel bit and symbol rates given in table 11 are the rates immediately before spreading.

Table 11: DPDCH and DPCCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Slot	DPDCH Bits/Slot		DPCCH Bits/Slot			Transmitted slots per radio frame N_{Tr}
					N_{Data1}	N_{Data2}	N_{TPC}	N_{TFCI}	N_{Pilot}	
0	15	7.5	512	10	0	4	2	0	4	15
0A	15	7.5	512	10	0	4	2	0	4	8-14
0B	30	15	256	20	0	8	4	0	8	8-14
1	15	7.5	512	10	0	2	2	2	4	15
1B	30	15	256	20	0	4	4	4	8	8-14
2	30	15	256	20	2	14	2	0	2	15
2A	30	15	256	20	2	14	2	0	2	8-14
2B	60	30	128	40	4	28	4	0	4	8-14
3	30	15	256	20	2	12	2	2	2	15
3A	30	15	256	20	2	10	2	4	2	8-14
3B	60	30	128	40	4	24	4	4	4	8-14
4	30	15	256	20	2	12	2	0	4	15
4A	30	15	256	20	2	12	2	0	4	8-14
4B	60	30	128	40	4	24	4	0	8	8-14
5	30	15	256	20	2	10	2	2	4	15
5A	30	15	256	20	2	8	2	4	4	8-14
5B	60	30	128	40	4	20	4	4	8	8-14
6	30	15	256	20	2	8	2	0	8	15
6A	30	15	256	20	2	8	2	0	8	8-14
6B	60	30	128	40	4	16	4	0	16	8-14
7	30	15	256	20	2	6	2	2	8	15
7A	30	15	256	20	2	4	2	4	8	8-14
7B	60	30	128	40	4	12	4	4	16	8-14
8	60	30	128	40	6	28	2	0	4	15
8A	60	30	128	40	6	28	2	0	4	8-14
8B	120	60	64	80	12	56	4	0	8	8-14
9	60	30	128	40	6	26	2	2	4	15
9A	60	30	128	40	6	24	2	4	4	8-14
9B	120	60	64	80	12	52	4	4	8	8-14
10	60	30	128	40	6	24	2	0	8	15
10A	60	30	128	40	6	24	2	0	8	8-14
10B	120	60	64	80	12	48	4	0	16	8-14
11	60	30	128	40	6	22	2	2	8	15
11A	60	30	128	40	6	20	2	4	8	8-14
11B	120	60	64	80	12	44	4	4	16	8-14
12	120	60	64	80	12	48	4	8*	8	15
12A	120	60	64	80	12	40	4	16*	8	8-14
12B	240	120	32	160	24	96	8	16*	16	8-14
13	240	120	32	160	28	112	4	8*	8	15
13A	240	120	32	160	28	104	4	16*	8	8-14
13B	480	240	16	320	56	224	8	16*	16	8-14
14	480	240	16	320	56	232	8	8*	16	15
14A	480	240	16	320	56	224	8	16*	16	8-14
14B	960	480	8	640	112	464	16	16*	32	8-14
15	960	480	8	640	120	488	8	8*	16	15
15A	960	480	8	640	120	480	8	16*	16	8-14
15B	1920	960	4	1280	240	976	16	16*	32	8-14
16	1920	960	4	1280	248	1000	8	8*	16	15
16A	1920	960	4	1280	248	992	8	16*	16	8-14

* If TFCI bits are not used, then DTX shall be used in TFCI field.

NOTE 1: Compressed mode is only supported through spreading factor reduction for SF=512 with TFCI.

NOTE 2: Compressed mode by spreading factor reduction is not supported for SF=4.

NOTE 3: If the Node B receives an invalid combination of data frames for downlink transmission, the procedure specified in [15], sub-clause 5.1.2,may require the use of DTX in both the DPDCH and theTFCI field of the DPCCH.

The pilot bit patterns are described in table 12. The shadowed column part of pilot bit pattern is defined as FSW and FSWs can be used to confirm frame synchronization. (The value of the pilot bit pattern other than FSWs shall be "11".) In table 12, the transmission order is from left to right.

In downlink compressed mode through spreading factor reduction, the number of bits in the TPC and Pilot fields are doubled. Symbol repetition is used to fill up the fields. Denote the bits in one of these fields in normal mode by x_1, x_2, x_3, …, x_X. In compressed mode the following bit sequence is sent in corresponding field: x_1, x_2, x_1, x_2, x_3, x_4, x_3, x_4,…, x_X,.

Table 12: Pilot bit patterns for downlink DPCCH with N_{pilot} = 2, 4, 8 and 16

	N_{pilot} = 2	N_{pilot} = 4 (*1)		N_{pilot} = 8 (*2)				N_{pilot} = 16 (*3)							
Symbol #	0	0	1	0	1	2	3	0	1	2	3	4	5	6	7
Slot #0	11	11	11	11	11	11	10	11	11	11	10	11	11	11	10
1	00	11	00	11	00	11	10	11	00	11	10	11	11	11	00
2	01	11	01	11	01	11	01	11	01	11	01	11	10	11	00
3	00	11	00	11	00	11	00	11	00	11	00	11	01	11	10
4	10	11	10	11	10	11	01	11	10	11	01	11	11	11	11
5	11	11	11	11	11	11	10	11	11	11	10	11	01	11	01
6	11	11	11	11	11	11	00	11	11	11	00	11	10	11	11
7	10	11	10	11	10	11	00	11	10	11	00	11	10	11	00
8	01	11	01	11	01	11	10	11	01	11	10	11	00	11	11
9	11	11	11	11	11	11	11	11	11	11	11	11	00	11	11
10	01	11	01	11	01	11	01	11	01	11	01	11	11	11	10
11	10	11	10	11	10	11	11	11	10	11	11	11	00	11	10
12	10	11	10	11	10	11	00	11	10	11	00	11	01	11	01
13	00	11	00	11	00	11	11	11	00	11	11	11	00	11	00
14	00	11	00	11	00	11	11	11	00	11	11	11	10	11	01

NOTE *1: This pattern is used except slot formats 2B and 3B.
NOTE *2: This pattern is used except slot formats 0B, 1B, 4B, 5B, 8B, and 9B.
NOTE *3: This pattern is used except slot formats 6B, 7B, 10B, 11B, 12B, and 13B.
NOTE: For slot format *n*B where *n* = 0, …, 15, the pilot bit pattern corresponding to $N_{pilot}/2$ is to be used and symbol repetition shall be applied.

The relationship between the TPC symbol and the transmitter power control command is presented in table 13.

Table 13: TPC Bit Pattern

TPC Bit Pattern			Transmitter power control command
N_{TPC} = 2	N_{TPC} = 4	N_{TPC} = 8	
11	1111	11111111	1
00	0000	00000000	0

Multicode transmission may be employed in the downlink, i.e. the CCTrCH (see [3]) is mapped onto several parallel downlink DPCHs using the same spreading factor. In this case, the Layer 1 control information is transmitted only on the first downlink DPCH. DTX bits are transmitted during the corresponding time period for the additional downlink DPCHs, see figure 10.

In case there are several CCTrCHs mapped to different DPCHs transmitted to the same UE different spreading factors can be used on DPCHs to which different CCTrCHs are mapped. Also in this case, Layer 1 control information is only transmitted on the first DPCH while DTX bits are transmitted during the corresponding time period for the additional DPCHs.

Note : support of multiple CCTrChs of dedicated type is not part of the current release.

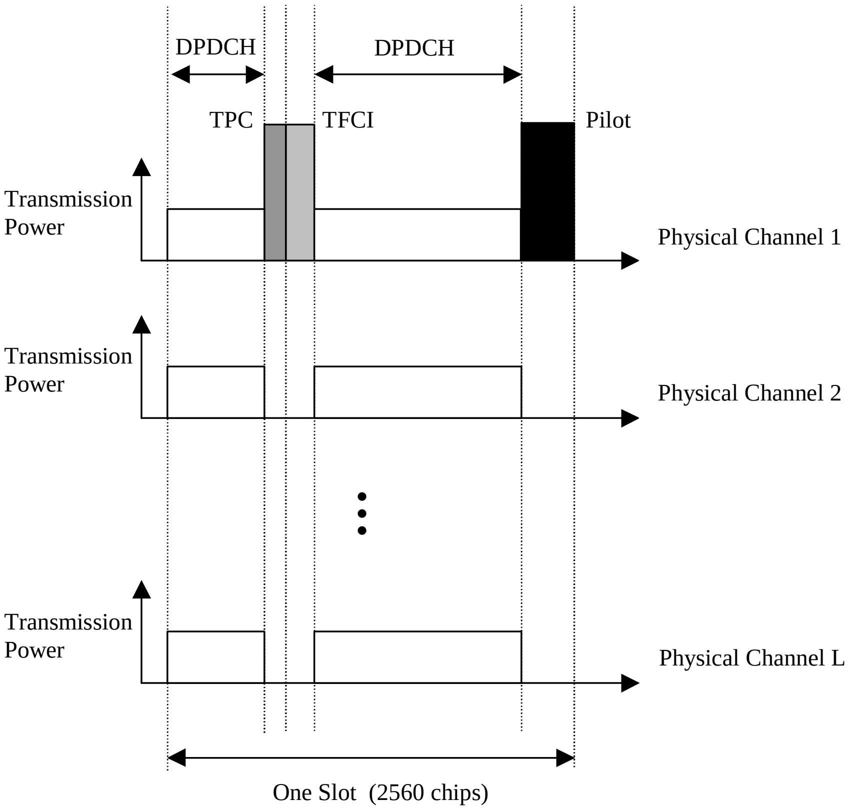

Figure 10: Downlink slot format in case of multi-code transmission

5.3.2.1 STTD for DPCH

The pilot bit pattern for the DPCH channel transmitted on antenna 2 is given in table 14.

- For N_{pilot} = 8, 16 the shadowed part indicates pilot bits that are obtained by STTD encoding the corresponding (shadowed) bits in Table 12. The non-shadowed pilot bit pattern is orthogonal to the corresponding (non-shadowed) pilot bit pattern in table 12.

- For N_{pilot} = 4, the diversity antenna pilot bit pattern is obtained by STTD encoding both the shadowed and non-shadowed pilot bits in table 12.

- For N_{pilot} = 2, the diversity antenna pilot pattern is obtained by STTD encoding the two pilot bits in table 12 with the last two bits (data or DTX) of the second data field (data2) of the slot. Thus for N_{pilot} = 2 case, the last two bits of the second data field (data 2) after STTD encoding, follow the diversity antenna pilot bits in Table 14.

STTD encoding for the DPDCH, TPC, and TFCI fields is done as described in subclause 5.3.1.1.1. For the SF=512 DPCH, the first two bits in each slot, i.e. TPC bits, are not STTD encoded and the same bits are transmitted with equal power from the two antennas. The remaining four bits are STTD encoded.

For compressed mode through spreading factor reduction and for N_{pilot} > 4, symbol repetition shall be applied to the pilot bit patterns of table 14, in the same manner as described in 5.3.2. For slot formats 2B and 3B, i.e. compressed mode through spreading factor reduction and N_{pilot} = 4, the pilot bits transmitted on antenna 2 are STTD encoded, and thus the pilot bit pattern is as shown in the most right set of table 14.

Table 14: Pilot bit patterns of downlink DPCCH for antenna 2 using STTD

	N_{pilot} = 2 (*1)	**N_{pilot} = 4** (*2)		**N_{pilot} = 8** (*3)				**N_{pilot} = 16** (*4)								**N_{pilot} = 4** (*5)	
Symbol #	0	0	1	0	1	2	3	0	1	2	3	4	5	6	7	0	1
Slot #0	01	01	10	11	00	00	10	11	00	00	10	11	00	00	10	01	10
1	10	10	10	11	00	00	01	11	00	00	01	11	10	00	10	10	01
2	11	11	10	11	11	00	00	11	11	00	00	11	10	00	11	11	00
3	10	10	10	11	10	00	01	11	10	00	01	11	00	00	00	10	01
4	00	00	10	11	11	00	11	11	11	00	11	11	01	00	10	00	11
5	01	01	10	11	00	00	10	11	00	00	10	11	11	00	00	01	10
6	01	01	10	11	10	00	10	11	10	00	10	11	01	00	11	01	10
7	00	00	10	11	10	00	11	11	10	00	11	11	10	00	11	00	11
8	11	11	10	11	00	00	00	11	00	00	00	11	01	00	01	11	00
9	01	01	10	11	01	00	10	11	01	00	10	11	01	00	01	01	10
10	11	11	10	11	11	00	00	11	11	00	00	11	00	00	10	11	00
11	00	00	10	11	01	00	11	11	01	00	11	11	00	00	01	00	11
12	00	00	10	11	10	00	11	11	10	00	11	11	11	00	00	00	11
13	10	10	10	11	01	00	01	11	01	00	01	11	10	00	01	10	01
14	10	10	10	11	01	00	01	11	01	00	01	11	11	00	11	10	01

NOTE *1: The pilot bits precede the last two bits of the data2 field.
NOTE *2: This pattern is used except slot formats 2B and 3B.
NOTE *3: This pattern is used except slot formats 0B, 1B, 4B, 5B, 8B, and 9B.
NOTE *4: This pattern is used except slot formats 6B, 7B, 10B, 11B, 12B, and 13B.
NOTE *5: This pattern is used for slot formats 2B and 3B.
NOTE: For slot format *n*B where *n* = 0, 1, 4, 5, 6, …, 15, the pilot bit pattern corresponding to $N_{pilot}/2$ is to be used and symbol repetition shall be applied.

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Athens, Greece, May 9-13, 2005

CR-Form-v7.1

CHANGE REQUEST

⌘	**25.211**	**CR**	**219**	⌘ **rev**	**-**	⌘	Current version:	**6.4.0**	⌘

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

Title:	⌘	Feature clean up: Removal of the 'compressed mode by puncturing'		
Source:	⌘	RAN WG1		
Work item code:	⌘	TEI6	***Date:*** ⌘	18/04/2005
Category:	⌘	C	***Release:*** ⌘	Rel-6
		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:* *Ph2 (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)* *Rel-7 (Release 7)*

Reason for change:	⌘	The feature 'compressed mode by puncturing' is not used in real networks. Furthermore, as compressed mode by puncturing is only applicable for fixed positions in DL, it not expected to be the best way of handling compressed mode measurements with future services. RAN #27 decided with RP-050144 to remove this feature.
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5.3.2 Dedicated downlink physical channels

There are four types of downlink dedicated physical channels, the Downlink Dedicated Physical Channel (downlink DPCH), the Fractional Dedicated Physical Channel (F-DPCH), the E-DCH Relative Grant Channel (E-RGCH), and the E-DCH Hybrid ARQ Indicator Channel (E-HICH).

The F-DPCH is described in subclause 5.3.2.6.

Within one downlink DPCH, dedicated data generated at Layer 2 and above, i.e. the dedicated transport channel (DCH), is transmitted in time-multiplex with control information generated at Layer 1 (known pilot bits, TPC commands, and an optional TFCI). The downlink DPCH can thus be seen as a time multiplex of a downlink DPDCH and a downlink DPCCH, compare subclause 5.2.1.

Figure 9 shows the frame structure of the downlink DPCH. Each frame of length 10 ms is split into 15 slots, each of length T_{slot} = 2560 chips, corresponding to one power-control period.

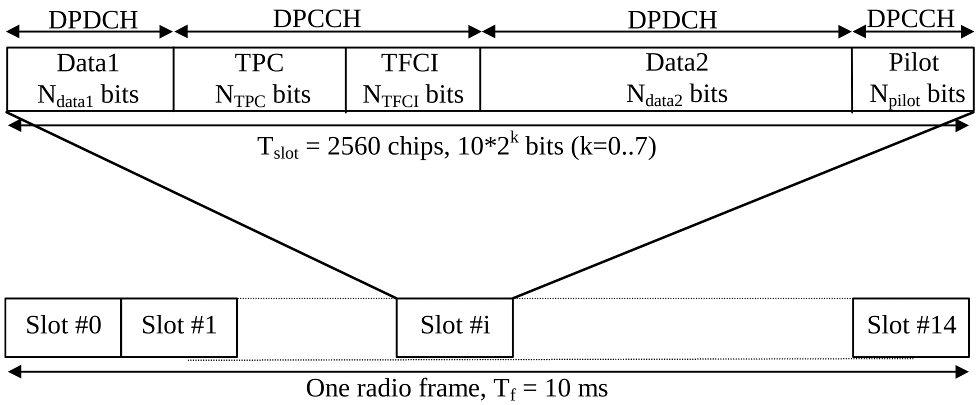

Figure 9: Frame structure for downlink DPCH

The parameter k in figure 9 determines the total number of bits per downlink DPCH slot. It is related to the spreading factor SF of the physical channel as SF = $512/2^k$. The spreading factor may thus range from 512 down to 4.

The exact number of bits of the different downlink DPCH fields (N_{pilot}, N_{TPC}, N_{TFCI}, N_{data1} and N_{data2}) is given in table 11. What slot format to use is configured by higher layers and can also be reconfigured by higher layers.

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In compressed frames, a different slot format is used compared to normal mode. There are two possible compressed slot formats that are labelled A and B. Slot format B shall be used in frames compressed by spreading factor reduction and slot format A shall be used in frames compressed by ~~puncturing or~~ higher layer scheduling. The channel bit and symbol rates given in table 11 are the rates immediately before spreading.

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0A	15	7.5	512	10	0	4	2	0	4	8-14
0B	30	15	256	20	0	8	4	0	8	8-14
1	15	7.5	512	10	0	2	2	2	4	15
1B	30	15	256	20	0	4	4	4	8	8-14
2	30	15	256	20	2	14	2	0	2	15
2A	30	15	256	20	2	14	2	0	2	8-14
2B	60	30	128	40	4	28	4	0	4	8-14
3	30	15	256	20	2	12	2	2	2	15
3A	30	15	256	20	2	10	2	4	2	8-14
3B	60	30	128	40	4	24	4	4	4	8-14
4	30	15	256	20	2	12	2	0	4	15
4A	30	15	256	20	2	12	2	0	4	8-14
4B	60	30	128	40	4	24	4	0	8	8-14
5	30	15	256	20	2	10	2	2	4	15
5A	30	15	256	20	2	8	2	4	4	8-14
5B	60	30	128	40	4	20	4	4	8	8-14
6	30	15	256	20	2	8	2	0	8	15
6A	30	15	256	20	2	8	2	0	8	8-14
6B	60	30	128	40	4	16	4	0	16	8-14
7	30	15	256	20	2	6	2	2	8	15
7A	30	15	256	20	2	4	2	4	8	8-14
7B	60	30	128	40	4	12	4	4	16	8-14
8	60	30	128	40	6	28	2	0	4	15
8A	60	30	128	40	6	28	2	0	4	8-14
8B	120	60	64	80	12	56	4	0	8	8-14
9	60	30	128	40	6	26	2	2	4	15
9A	60	30	128	40	6	24	2	4	4	8-14
9B	120	60	64	80	12	52	4	4	8	8-14
10	60	30	128	40	6	24	2	0	8	15
10A	60	30	128	40	6	24	2	0	8	8-14
10B	120	60	64	80	12	48	4	0	16	8-14
11	60	30	128	40	6	22	2	2	8	15
11A	60	30	128	40	6	20	2	4	8	8-14
11B	120	60	64	80	12	44	4	4	16	8-14
12	120	60	64	80	12	48	4	8*	8	15
12A	120	60	64	80	12	40	4	16*	8	8-14
12B	240	120	32	160	24	96	8	16*	16	8-14
13	240	120	32	160	28	112	4	8*	8	15
13A	240	120	32	160	28	104	4	16*	8	8-14
13B	480	240	16	320	56	224	8	16*	16	8-14
14	480	240	16	320	56	232	8	8*	16	15
14A	480	240	16	320	56	224	8	16*	16	8-14
14B	960	480	8	640	112	464	16	16*	32	8-14
15	960	480	8	640	120	488	8	8*	16	15
15A	960	480	8	640	120	480	8	16*	16	8-14
15B	1920	960	4	1280	240	976	16	16*	32	8-14
16	1920	960	4	1280	248	1000	8	8*	16	15
16A	1920	960	4	1280	248	992	8	16*	16	8-14

* If TFCI bits are not used, then DTX shall be used in TFCI field.

NOTE 1: Compressed mode is only supported through spreading factor reduction for SF=512 with TFCI.

NOTE 2: Compressed mode by spreading factor reduction is not supported for SF=4.

NOTE 3: If the Node B receives an invalid combination of data frames for downlink transmission, the procedure specified in [15], sub-clause 5.1.2,may require the use of DTX in both the DPDCH and theTFCI field of the DPCCH.

The pilot bit patterns are described in table 12. The shadowed column part of pilot bit pattern is defined as FSW and FSWs can be used to confirm frame synchronization. (The value of the pilot bit pattern other than FSWs shall be "11".) In table 12, the transmission order is from left to right.

In downlink compressed mode through spreading factor reduction, the number of bits in the TPC and Pilot fields are doubled. Symbol repetition is used to fill up the fields. Denote the bits in one of these fields in normal mode by x_1, x_2, x_3, …, x_X. In compressed mode the following bit sequence is sent in corresponding field: x_1, x_2, x_1, x_2, x_3, x_4, x_3, x_4,…, x_X,.

Table 12: Pilot bit patterns for downlink DPCCH with N_{pilot} = 2, 4, 8 and 16

	N_{pilot} = 2	N_{pilot} = 4 (*1)		N_{pilot} = 8 (*2)				N_{pilot} = 16 (*3)							
Symbol #	0	0	1	0	1	2	3	0	1	2	3	4	5	6	7
Slot #0	11	11	11	11	11	11	10	11	11	11	10	11	11	11	10
1	00	11	00	11	00	11	10	11	00	11	10	11	11	11	00
2	01	11	01	11	01	11	01	11	01	11	01	11	10	11	00
3	00	11	00	11	00	11	00	11	00	11	00	11	01	11	10
4	10	11	10	11	10	11	01	11	10	11	01	11	11	11	11
5	11	11	11	11	11	11	10	11	11	11	10	11	01	11	01
6	11	11	11	11	11	11	00	11	11	11	00	11	10	11	11
7	10	11	10	11	10	11	00	11	10	11	00	11	10	11	00
8	01	11	01	11	01	11	10	11	01	11	10	11	00	11	11
9	11	11	11	11	11	11	11	11	11	11	11	11	00	11	11
10	01	11	01	11	01	11	01	11	01	11	01	11	11	11	10
11	10	11	10	11	10	11	11	11	10	11	11	11	00	11	10
12	10	11	10	11	10	11	00	11	10	11	00	11	01	11	01
13	00	11	00	11	00	11	11	11	00	11	11	11	00	11	00
14	00	11	00	11	00	11	11	11	00	11	11	11	10	11	01

NOTE *1: This pattern is used except slot formats 2B and 3B.
NOTE *2: This pattern is used except slot formats 0B, 1B, 4B, 5B, 8B, and 9B.
NOTE *3: This pattern is used except slot formats 6B, 7B, 10B, 11B, 12B, and 13B.
NOTE: For slot format *n*B where *n* = 0, …, 15, the pilot bit pattern corresponding to $N_{pilot}/2$ is to be used and symbol repetition shall be applied.

The relationship between the TPC symbol and the transmitter power control command is presented in table 13.

Table 13: TPC Bit Pattern

TPC Bit Pattern			Transmitter power control command
N_{TPC} = 2	N_{TPC} = 4	N_{TPC} = 8	
11	1111	11111111	1
00	0000	00000000	0

Multicode transmission may be employed in the downlink, i.e. the CCTrCH (see [3]) is mapped onto several parallel downlink DPCHs using the same spreading factor. In this case, the Layer 1 control information is transmitted only on the first downlink DPCH. DTX bits are transmitted during the corresponding time period for the additional downlink DPCHs, see figure 10.

In case there are several CCTrCHs mapped to different DPCHs transmitted to the same UE different spreading factors can be used on DPCHs to which different CCTrCHs are mapped. Also in this case, Layer 1 control information is only transmitted on the first DPCH while DTX bits are transmitted during the corresponding time period for the additional DPCHs.

Note : support of multiple CCTrChs of dedicated type is not part of the current release.

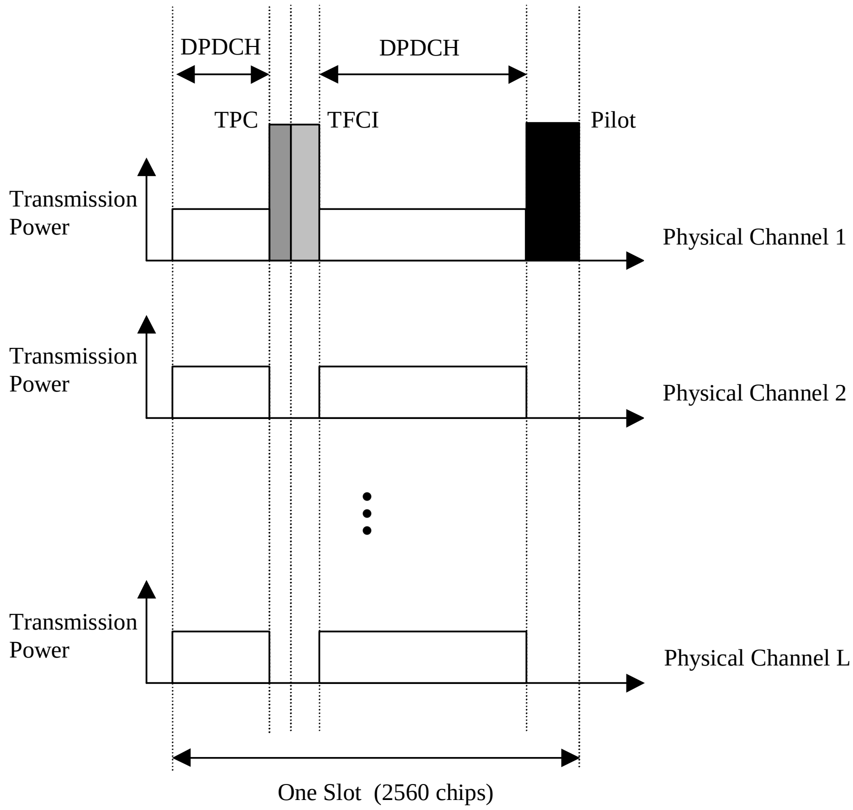


Figure 10: Downlink slot format in case of multi-code transmission

5.3.2.1 STTD for DPCH and F-DPCH

The pilot bit pattern for the DPCH channel transmitted on antenna 2 is given in table 14.

- For N_{pilot} = 8, 16 the shadowed part indicates pilot bits that are obtained by STTD encoding the corresponding (shadowed) bits in Table 12. The non-shadowed pilot bit pattern is orthogonal to the corresponding (non-shadowed) pilot bit pattern in table 12.
- For N_{pilot} = 4, the diversity antenna pilot bit pattern is obtained by STTD encoding both the shadowed and non-shadowed pilot bits in table 12.
- For N_{pilot} = 2, the diversity antenna pilot pattern is obtained by STTD encoding the two pilot bits in table 12 with the last two bits (data or DTX) of the second data field (data2) of the slot. Thus for N_{pilot} = 2 case, the last two bits of the second data field (data 2) after STTD encoding, follow the diversity antenna pilot bits in Table 14.

STTD encoding for the DPDCH, TPC, and TFCI fields is done as described in subclause 5.3.1.1.1. For the SF=512 DPCH, the first two bits in each slot, i.e. TPC bits, are not STTD encoded and the same bits are transmitted with equal power from the two antennas. The remaining four bits are STTD encoded.

For F-DPCH, the TPC bits are not STTD encoded and the same bits are transmitted with equal power from the two antennas.

For compressed mode through spreading factor reduction and for N_{pilot} > 4, symbol repetition shall be applied to the pilot bit patterns of table 14, in the same manner as described in 5.3.2. For slot formats 2B and 3B, i.e. compressed mode through spreading factor reduction and N_{pilot} = 4, the pilot bits transmitted on antenna 2 are STTD encoded, and thus the pilot bit pattern is as shown in the most right set of table 14.

Table 14: Pilot bit patterns of downlink DPCCH for antenna 2 using STTD

	N_{pilot} = 2 (*1)	N_{pilot} = 4 (*2)		N_{pilot} = 8 (*3)				N_{pilot} = 16 (*4)								N_{pilot} = 4 (*5)	
Symbol #	0	0	1	0	1	2	3	0	1	2	3	4	5	6	7	0	1
Slot #0	01	01	10	11	00	00	10	11	00	00	10	11	00	00	10	01	10
1	10	10	10	11	00	00	01	11	00	00	01	11	10	00	10	10	01
2	11	11	10	11	11	00	00	11	11	00	00	11	10	00	11	11	00
3	10	10	10	11	10	00	01	11	10	00	01	11	00	00	00	10	01
4	00	00	10	11	11	00	11	11	11	00	11	11	01	00	10	00	11
5	01	01	10	11	00	00	10	11	00	00	10	11	11	00	00	01	10
6	01	01	10	11	10	00	10	11	10	00	10	11	01	00	11	01	10
7	00	00	10	11	10	00	11	11	10	00	11	11	10	00	11	00	11
8	11	11	10	11	00	00	00	11	00	00	00	11	01	00	01	11	00
9	01	01	10	11	01	00	10	11	01	00	10	11	01	00	01	01	10
10	11	11	10	11	11	00	00	11	11	00	00	11	00	00	10	11	00
11	00	00	10	11	01	00	11	11	01	00	11	11	00	00	01	00	11
12	00	00	10	11	10	00	11	11	10	00	11	11	11	00	00	00	11
13	10	10	10	11	01	00	01	11	01	00	01	11	10	00	01	10	01
14	10	10	10	11	01	00	01	11	01	00	01	11	11	00	11	10	01

NOTE *1: The pilot bits precede the last two bits of the data2 field.
NOTE *2: This pattern is used except slot formats 2B and 3B.
NOTE *3: This pattern is used except slot formats 0B, 1B, 4B, 5B, 8B, and 9B.
NOTE *4: This pattern is used except slot formats 6B, 7B, 10B, 11B, 12B, and 13B.
NOTE *5: This pattern is used for slot formats 2B and 3B.
NOTE: For slot format *n*B where *n* = 0, 1, 4, 5, 6, …, 15, the pilot bit pattern corresponding to $N_{pilot}/2$ is to be used and symbol repetition shall be applied.

3GPP TSG-RAN1 Meeting #41
Athens, Greece, 9 - 13 May 2005

Tdoc ⌘R1-050525

CR-Form-v7.1

CHANGE REQUEST

⌘	25.212	CR	213	⌘ rev	1	⌘	Current version:	5.9.0	⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

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

Title:	⌘	Feature clean up: Removal of the 'compressed mode by puncturing'
Source:	⌘	RAN WG1
Work item code:	⌘	TEI5
Date:	⌘	12/05/2005
Category:	⌘	**C**
Release:	⌘	Rel-5

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:
- *Ph2 (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)*
- *Rel-7 (Release 7)*

Reason for change:	⌘	RAN #27 decided with RP-050144 to remove the feature 'CM by puncturing'.
Summary of change:	⌘	Text regarding the feature 'CM by puncturing' is removed.
Consequences if not approved:	⌘	Simplification of specifications and reduction of complexity would be missed. Further the RAN #27 decision would be violated.

Clauses affected:	⌘			4.2.5, 4.2.5.1, 4.2.5.3, 4.2.5.4, 4.2.7, 4.2.7.2, 4.2.7.2.1.2, 4.2.7.2.1.3, 4.2.9.1, 4.2.9.2, 4.2.10, 4.4.3, 4.4.3.1		
		Y	**N**			
Other specs affected:	⌘	X		Other core specifications	⌘	25.101, 25.133, 25.211, 25.214, 25.215, 25.331, 25.423, 25.433
				Test specifications		
			X	O&M Specifications		
Other comments:	⌘			Revision of R1-050479 with changes to 4.2.5.3, 4.2.5.4, 4.2.7		

How to create CRs using this form:

Comprehensive information and tips about how to create CRs can be found at http://www.3gpp.org/specs/CR.htm. Below is a brief summary:

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.

4.2.5 1st interleaving

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

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

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

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

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

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

$P1_{F_i}(x)$ defines the inter column permutation function for a TTI of length $F_i \times 10$ms, as defined in Table 4 in section 4.2.5.2. $P1_{F_i}(x)$ is the Bit Reversal function of x on $\log_2(F_i)$ bits.

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

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

col = 0

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

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

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

  col = col +1

end do

n = 0, m = 0

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

  col = n mod F_i

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

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

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

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

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

    m = m+1

~~endif~~

~~n = n +1~~

~~end do~~

4.2.5.2 1st interleaver operation

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

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

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

$$\text{R1} = X_i / \text{C1}.$$

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

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

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

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

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

(5) Read the output bit sequence $y_{i,1}, y_{i,2}, y_{i,3}, \ldots, y_{i,(\text{C1}\times\text{R1})}$ of the block interleaver column by column from the inter-column permuted R1 $\times$ C1 matrix. Bit $y_{i,1}$ corresponds to row 0 of column 0 and bit $y_{i,(\text{R1}\times\text{C1})}$ corresponds to row R1 - 1 of column C1 - 1.

Table 4 Inter-column permutation patterns for 1st interleaving

TTI	**Number of columns C1**	**Inter-column permutation patterns** <$\text{P1}_{\text{C1}}(0)$, $\text{P1}_{\text{C1}}(1)$, …, $\text{P1}_{\text{C1}}(\text{C1-1})$>
10 ms	1	<0>
20 ms	2	<0,1>
40 ms	4	<0,2,1,3>
80 ms	8	<0,4,2,6,1,5,3,7>

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

The bits input to the 1st interleaving are denoted by $t_{i,1}, t_{i,2}, t_{i,3}, \ldots, t_{i,T_i}$, where i is the TrCH number and T_i the number of bits. Hence, x~~z~~$_{i,k} = t_{i,k}$ and X~~Z~~$_i = T_i$.

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

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

If fixed positions of the TrCHs in a radio frame is used then the bits input to the 1st interleaving are denoted by $h_{i1}, h_{i2}, h_{i3}, \ldots, h_{iD_i}$, where i is the TrCH number. Hence, x~~z~~$_{ik} = h_{ik}$ and X~~Z~~$_i = D_i$.

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

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

4.2.6 Radio frame segmentation

When the transmission time interval is longer than 10 ms, the input bit sequence is segmented and mapped onto consecutive F_i radio frames. Following rate matching in the DL and radio frame size equalisation in the UL the input bit sequence length is guaranteed to be an integer multiple of F_i.

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 F_i 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:

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

where

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

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 to 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, $f_{i,k} = y_{i,n_i k}$ 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 TrCH multiplexing is identical to the total channel bit rate of the allocated dedicated physical channels.

If no bits are input to the rate matching for all TrCHs within a CCTrCH, the rate matching shall output no bits for all TrCHs within the CCTrCH and no uplink DPDCH will be selected in the case of uplink rate matching.

Notation used in subclause 4.2.7 and subclauses:

$N_{i,j}$: For uplink: Number of bits in a radio frame before rate matching on TrCH i with transport format combination j .

For downlink: An intermediate calculation variable (not an integer but a multiple of 1/8).

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

$\Delta N_{i,j}$: For uplink: If positive - number of bits that should be repeated in each radio frame on TrCH i with transport format combination j.

If negative - number of bits that should be punctured in each radio frame on TrCH i with transport format combination j.

For downlink : An intermediate calculation variable (not an integer but a multiple of 1/8).

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

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

Used in downlink only.

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

~~Used in downlink only.~~

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

~~Used in downlink only.~~

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

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

PL: Puncturing limit for uplink. This value limits the amount of puncturing that can be applied in order to avoid multicode or to enable the use of a higher spreading factor. Signalled from higher layers. The allowed puncturing in % is actually equal to (1-PL)*100.

$N_{data,j}$: Total number of bits that are available for the CCTrCH in a radio frame with transport format combination j.

I: Number of TrCHs in the CCTrCH.

$Z_{i,j}$: Intermediate calculation variable.

F_i: Number of radio frames in the transmission time interval of TrCH i.

F_{max} Maximum number of radio frames in a transmission time interval used in the CCTrCH :

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

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

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

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

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

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

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

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

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

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

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

b: Indicates systematic and parity bits

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

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

b=3: 2nd parity bit (from the lower Turbo constituent encoder). z'_k in subclause 4.2.3.2.1.

The * (star) notation is used to replace an index x when the indexed variable X_x does not depend on the index x. In the left wing of an assignment the meaning is that "$X_* = Y$" is equivalent to "**for all** $\underline{x}$ **do** $X_x = Y$ ". In the right wing of an assignment, the meaning is that "$Y = X_*$ " is equivalent to "**take any** $\underline{x}$ **and do** $Y = X_x$".

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

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

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

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

4.2.7.1 Determination of rate matching parameters in uplink

4.2.7.1.1 Determination of SF and number of PhCHs needed

In uplink, puncturing can be applied to match the CCTrCH bit rate to the PhCH bit rate. The bit rate of the PhCH(s) is limited by the UE capability and restrictions imposed by UTRAN, through limitations on the PhCH spreading factor. The maximum amount of puncturing that can be applied is 1-PL, PL is signalled from higher layers. The number of available bits in the radio frames of one PhCH for all possible spreading factors is given in [2]. Denote these values by N_{256}, N_{128}, N_{64}, N_{32}, N_{16}, N_8, and N_4, where the index refers to the spreading factor. The possible number of bits available to the CCTrCH on all PhCHs, N_{data}, then are { N_{256}, N_{128}, N_{64}, N_{32}, N_{16}, N_8, N_4, $2\times N_4$, $3\times N_4$, $4\times N_4$, $5\times N_4$, $6\times N_4$}.

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

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

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

If SET1 is not empty and the smallest element of SET1 requires just one PhCH then

$N_{data,j}$ = min SET1

else

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

Sort SET2 in ascending order

N_{data} = min SET2

While N_{data} is not the max of SET2 and the follower of N_{data} requires no additional PhCH do

N_{data} = follower of N_{data} in SET2

End while

$N_{data,j} = N_{data}$

End if

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

4.2.7.1.2 Determination of parameters needed for calculating the rate matching pattern

The number of bits to be repeated or punctured, $\Delta N_{i,j}$, within one radio frame for each TrCH i is calculated with equation 1 for all possible transport format combinations j and selected every radio frame. $N_{data,j}$ is given from subclause 4.2.7.1.1.

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

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

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

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

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

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

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

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

If $\Delta N_{i,j} \ne 0$ the parameters listed in subclauses 4.2.7.1.2.1 and 4.2.7.1.2.2 shall be used for determining e_{ini}, e_{plus}, and e_{minus} (regardless if the radio frame is compressed or not).

4.2.7.1.2.1 Convolutionally encoded TrCHs

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

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

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

else

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

endif

-- note: q is a signed quantity.

if q is even

then q' = q + gcd(|q|, F_i)/ F_i -- where gcd (|q|, F_i) means greatest common divisor of |q| and F_i

-- note that q' is not an integer, but a multiple of 1/8

else

q' = q

endif

for x = 0 to F_i - 1

S[$|\lfloor x \times q' \rfloor|$ mod F_i] = ($|\lfloor x \times q' \rfloor|$ div F_i)

end for

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

a = 2

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

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

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

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

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

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

4.2.7.1.2.2 Turbo encoded TrCHs

If repetition is to be performed on turbo encoded TrCHs, i.e. $\Delta N_{i,j} > 0$, the parameters in subclause 4.2.7.1.2.1 are used.

If puncturing is to be performed, the parameters below shall be used. Index b is used to indicate systematic (b=1), 1st parity (b=2), and 2nd parity bit (b=3).

$a=2$ when b=2

$a=1$ when b=3

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

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

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

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

if($q \leq 2$)

for r=0 to F_i-1

$S[(3 \times r + b - 1) \bmod F_I] = r \bmod 2$;

end for

else

if q is even

then $q' = q - gcd(q, F_i) / F_i$ -- where $gcd(q, F_i)$ means greatest common divisor of q and F_i
-- note that q' is not an integer, but a multiple of 1/8

else q' = q

endif

for x=0 to F_i -1

$r = \lceil x \times q' \rceil \bmod F_i$;

$S[(3 \times r + b - 1) \bmod F_i] = \lceil x \times q' \rceil \text{ div } F_i$;

endfor

endif

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

X_i is as above:

$e_{ini} = (a \times S[P1_{Fi}(n_i)] \times |\Delta N_i| + X_i) \bmod (a \times X_i)$, if $e_{ini} = 0$ then $e_{ini} = a \times X_i$

$e_{plus} = a \times X_i$

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

4.2.7.2 Determination of rate matching parameters in downlink

For downlink channels other than the downlink shared channel(s) (DSCH), $N_{data,j}$ does not depend on the transport format combination j. $N_{data,*}$ is given by the channelization code(s) assigned by higher layers.

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

For a DSCH CCTrCH , different sets of channelisation codes may be configured by higher layers resulting in possibly multiple $N_{data,*}$ values, where $N_{data,*}$ is the number of bits available to the CCTrCH in one radio frame and is given by $N_{data,*}=P\times15\times(N_{data1}+N_{data2})$, where N_{data1} and N_{data2} are defined in [2]. Each $N_{data,*}$ corresponds to a sub-set of the Transport format combinations configured as part of the TFCS. For a DSCH CCTrCH only flexible positions apply. The rate matching calculations as specified in section 4.2.7.2.2 shall be performed for each $N_{data,*}$, where the TFCS taken into account in the calculations is restricted to the set of TFCs associated with $N_{data,*}$, as configured by higher layers. Therefore the amount of rate matching for a transport channel i for a TTI interval is a function of the $N_{data,*}$ value which shall be constant over the entire TTI as specified in section 4.2.14.

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

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

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

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

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

~~In case of compressed mode by puncturing and fixed positions, for some calculations, $N'_{data,*}$ is used for radio frames with gap instead of $N_{data,*}$, where $N'_{data,*} = P \times 15 \times (N'_{data1} + N'_{data2})$. N'_{data1} and N'_{data2} are the number of bits in the data fields of the slot format used for the frames compressed by puncturing.~~

4.2.7.2.1 Determination of rate matching parameters for fixed positions of TrCHs

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

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

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

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

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

If $\Delta N_{i,max} = 0$ then, for TrCH *i*, the output data of the rate matching is the same as the input data and the rate matching algorithm of subclause 4.2.7.5 does not need to be executed. In this case we have :

$$\forall l \in TFS(i)\ \Delta N_{i,l}^{TTI} = 0$$

If $\Delta N_{i,max} \neq 0$ the parameters listed in subclauses 4.2.7.2.1.3 and 4.2.7.2.1.4 shall be used for determining e_{ini}, e_{plus}, and e_{minus}, and $\Delta N_{i,l}^{TTI}$.

4.2.7.2.1.2 ~~Calculations for compressed mode by puncturing~~Void

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

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

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

~~Then an intermediate calculation variable $\Delta N_{i,*}$ is derived from $N_{i,*}$ by the formula given at subclause 4.2.7, for all TrCH *i*.~~

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

If $\Delta N_{i,\max}^{TTI,cm,m} = 0$, then, for TrCH *i*, the output data of the rate matching is the same as the input data and the rate matching algorithm of subclause 4.2.7.5 does not need to be executed.

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

4.2.7.2.1.3 Determination of rate matching parameters for convolutionally encoded TrCHs

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

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

a=2

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

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

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

$$e_{ini} = 1$$

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

$$e_{\min us} = a \times |\Delta N_i|$$

Puncturing if $\Delta N_i < 0$, repetition otherwise. The values of $\Delta N_{i,l}^{TTI}$ may be computed by counting repetitions or puncturing when the algorithm of subclause 4.2.7.5 is run. The resulting values of $\Delta N_{i,l}^{TTI}$ can be represented with following expression.

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

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

4.2.7.2.1.4 Determination of rate matching parameters for Turbo encoded TrCHs

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

If puncturing is to be performed, the parameters below shall be used. Index *b* is used to indicate systematic (*b*=1), 1st parity (*b*=2), and 2nd parity bit (*b*=3).

$a=2$ when $b=2$

$a=1$ when $b=3$

The bits indicated by *b*=1 shall not be punctured.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.2.7.2.2 Determination of rate matching parameters for flexible positions of TrCHs

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

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

$$N_{i,j} = \frac{1}{F_i} \times N_{i,TF_i(j)}^{TTI}$$

Then rate matching ratios RF_i are calculated for each the transport channel *i* in order to minimise the number of DTX bits when the bit rate of the CCTrCH is maximum. The RF_i ratios are defined by the following formula:

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

The computation of $\Delta N_{i,l}^{TTI}$ parameters is then performed in two phases. In a first phase, tentative temporary values of $\Delta N_{i,l}^{TTI}$ are computed, and in the second phase they are checked and corrected. The first phase, by use of the RF_i ratios, ensures that the number of DTX indication bits inserted is minimum when the CCTrCH bit rate is maximum, but it does not ensure that the maximum CCTrCH bit rate is not greater than $N_{data,*}$. per 10ms. The latter condition is ensured through the checking and possible corrections carried out in the second phase.

At the end of the second phase, the latest value of $\Delta N_{i,l}^{TTI}$ is the definitive value.

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

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

The second phase is defined by the following algorithm:

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

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

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

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

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

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

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

end-if

end-for

end-if

end-for

If $\Delta N_{i,l}^{TTI} = 0$ then, for TrCH *i* at TF *l*, the output data of the rate matching is the same as the input data and the rate matching algorithm of subclause 4.2.7.5 does not need to be executed.

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

4.2.7.2.2.2 Determination of rate matching parameters for convolutionally encoded TrCHs

$\Delta N_i = \Delta N_{il}^{TTI}$

$a=2$

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

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

$e_{ini} = 1$

$e_{plus} = a \times N_{il}^{TTI}$

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

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

4.2.7.2.2.3 Determination of rate matching parameters for Turbo encoded TrCHs

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

If puncturing is to be performed, the parameters below shall be used. Index *b* is used to indicate systematic (*b*=1), 1st parity (*b*=2), and 2nd parity bit (*b*=3).

$a=2$ when $b=2$

$a=1$ when $b=3$

The bits indicated by *b*=1 shall not be punctured.

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

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

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

$e_{ini} = X_i$,

$e_{plus} = a \times X_i$

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

4.2.7.3 Bit separation and collection in uplink

The systematic bits of turbo encoded TrCHs shall not be punctured, the other bits may be punctured. The systematic bits, first parity bits, and second parity bits in the bit sequence input to the rate matching block are therefore separated into three sequences.

The first sequence contains:

- All of the systematic bits that are from turbo encoded TrCHs.
- From 0 to 2 first and/or second parity bits that are from turbo encoded TrCHs. These bits come into the first sequence when the total number of bits in a block after radio frame segmentation is not a multiple of three.
- Some of the systematic, first parity and second parity bits that are for trellis termination.

The second sequence contains:

- All of the first parity bits that are from turbo encoded TrCHs, except those that go into the first sequence when the total number of bits is not a multiple of three.
- Some of the systematic, first parity and second parity bits that are for trellis termination.

The third sequence contains:

- All of the second parity bits that are from turbo encoded TrCHs, except those that go into the first sequence when the total number of bits is not a multiple of three.
- Some of the systematic, first parity and second parity bits that are for trellis termination.

The second and third sequences shall be of equal length, whereas the first sequence can contain from 0 to 2 more bits. Puncturing is applied only to the second and third sequences.The bit separation function is transparent for convolutionally encoded TrCHs and for turbo encoded TrCHs with repetition. The bit separation and bit collection are illustrated in figures 5 and 6.

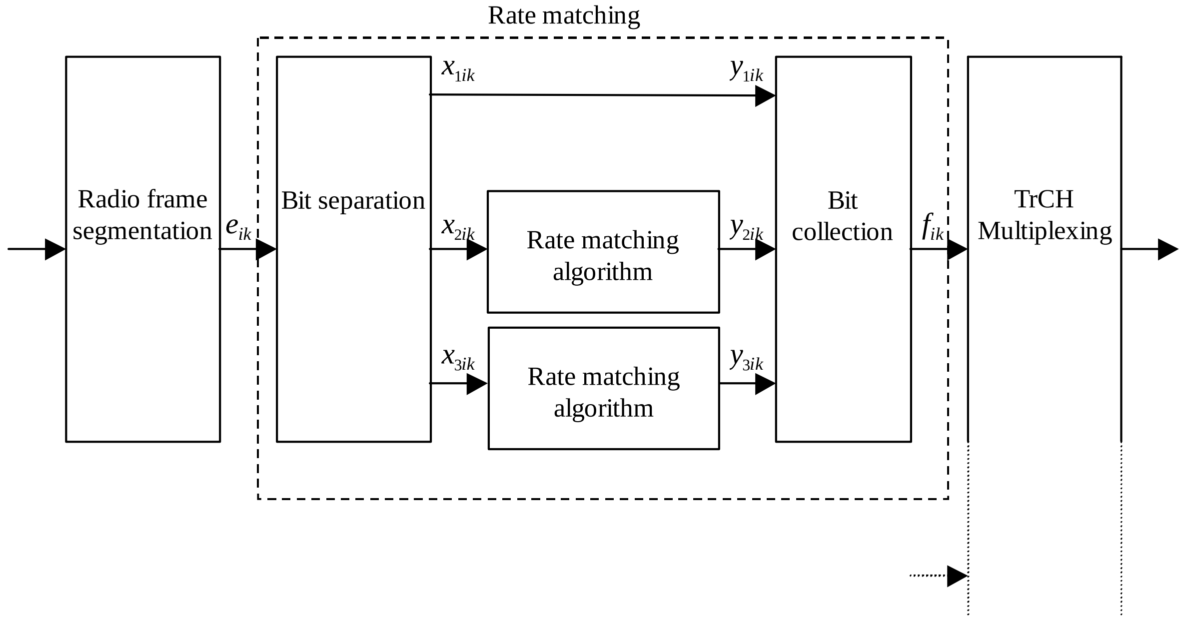


Figure 5: Puncturing of turbo encoded TrCHs in uplink

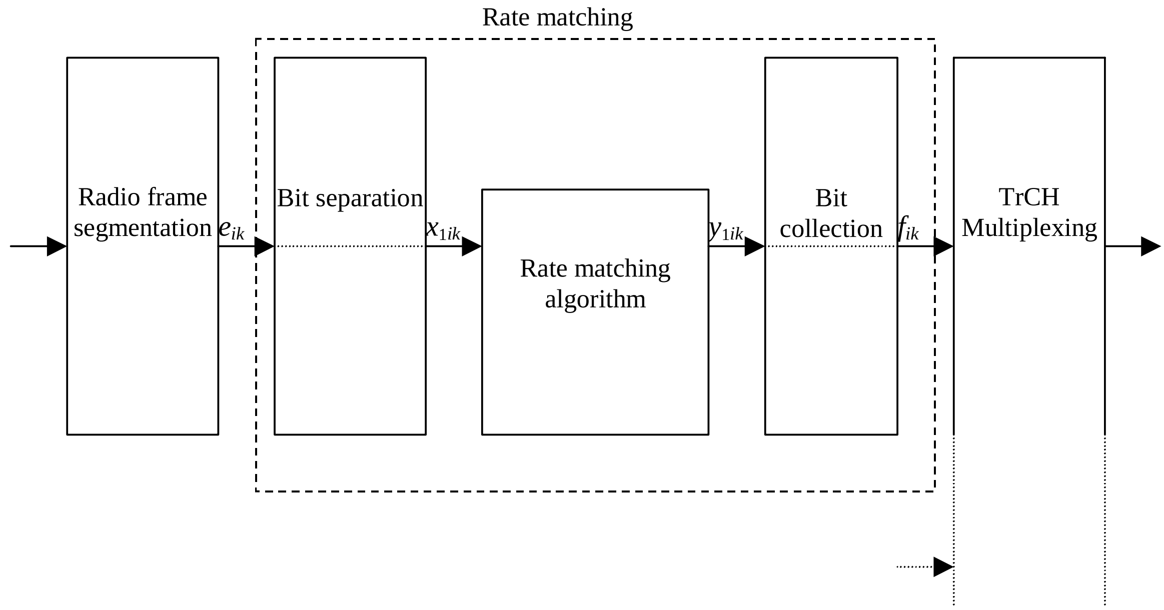


Figure 6: Rate matching for convolutionally encoded TrCHs and for turbo encoded TrCHs with repetition in uplink

The bit separation is dependent on the 1st interleaving and offsets are used to define the separation for different TTIs. b indicates the three sequences defined in this section, with b=1 indicating the first sequence, b = 2 the second one, and b = 3 the third one. The offsets α_b for these sequences are listed in table 5.

Table 5: TTI dependent offset needed for bit separation

TTI (ms)	α_1	α_2	α_3
10, 40	0	1	2
20, 80	0	2	1

The bit separation is different for different radio frames in the TTI. A second offset is therefore needed. The radio frame number for TrCH i is denoted by n_i. and the offset by β_{n_i} .

Table 6: Radio frame dependent offset needed for bit separation

TTI (ms)	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
10	0	NA	NA	NA	NA	NA	NA	NA
20	0	1	NA	NA	NA	NA	NA	NA
40	0	1	2	0	NA	NA	NA	NA
80	0	1	2	0	1	2	0	1

4.2.7.3.1 Bit separation

The bits input to the rate matching are 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 input to the rate matching block. Note that the transport format combination number *j* for simplicity has been left out in the bit numbering, i.e. $N_i=N_{ij}$. The bits after separation are denoted by $x_{bi1}, x_{bi2}, x_{bi3}, \ldots, x_{biX_i}$. For turbo encoded TrCHs with puncturing, *b* indicates the three sequences defined in section 4.2.7.3, with *b*=1 indicating the first sequence, and so forth. For all other cases *b* is defined to be 1. X_i is the number of bits in each separated bit sequence. The relation between e_{ik} and x_{bik} is given below.

For turbo encoded TrCHs with puncturing:

$x_{1,i,k} = e_{i,3(k-1)+1+(\alpha_1+\beta_{n_i}) \bmod 3}$ $k = 1, 2, 3, \ldots, X_i$ $X_i = \lfloor N_i/3 \rfloor$

$x_{1,i,\lfloor N_i/3 \rfloor+k} = e_{i,3\lfloor N_i/3 \rfloor+k}$ $k = 1, \ldots, N_i \bmod 3$ Note: When (N_i mod 3) = 0 this row is not needed.

$x_{2,i,k} = e_{i,3(k-1)+1+(\alpha_2+\beta_{n_i}) \bmod 3}$ $k = 1, 2, 3, \ldots, X_i$ $X_i = \lfloor N_i/3 \rfloor$

$x_{3,i,k} = e_{i,3(k-1)+1+(\alpha_3+\beta_{n_i}) \bmod 3}$ $k = 1, 2, 3, \ldots, X_i$ $X_i = \lfloor N_i/3 \rfloor$

For convolutionally encoded TrCHs and turbo encoded TrCHs with repetition:

$x_{1,i,k} = e_{i,k}$ $k = 1, 2, 3, \ldots, X_i$ $X_i = N_i$

4.2.7.3.2 Bit collection

The bits x_{bik} are input to the rate matching algorithm described in subclause 4.2.7.5. The bits output from the rate matching algorithm are denoted $y_{bi1}, y_{bi2}, y_{bi3}, \ldots, y_{biY_i}$.

Bit collection is the inverse function of the separation. The bits after collection are denoted by $z_{bi1}, z_{bi2}, z_{bi3}, \ldots, z_{biY_i}$. After bit collection, the bits indicated as punctured are removed and the bits are then denoted by $f_{i1}, f_{i2}, f_{i3}, \ldots, f_{iV_i}$, where *i* is the TrCH number and $V_i = N_{ij} + \Delta N_{ij}$. The relations between y_{bik}, z_{bik}, and f_{ik} are given below.

For turbo encoded TrCHs with puncturing ($Y_i=X_i$):

$z_{i,3(k-1)+1+(\alpha_1+\beta_{n_i}) \bmod 3} = y_{1,i,k}$ $k = 1, 2, 3, \ldots, Y_i$

$z_{i,3\lfloor N_i/3 \rfloor+k} = y_{1,i,\lfloor N_i/3 \rfloor+k}$ $k = 1, \ldots, N_i \bmod 3$ Note: When (N_i mod 3) = 0 this row is not needed.

$z_{i,3(k-1)+1+(\alpha_2+\beta_{n_i}) \bmod 3} = y_{2,i,k}$ $k = 1, 2, 3, \ldots, Y_i$

$z_{i,3(k-1)+1+(\alpha_3+\beta_{n_i}) \bmod 3} = y_{3,i,k}$ $k = 1, 2, 3, \ldots, Y_i$

After the bit collection, bits $z_{i,k}$ with value δ, where $\delta \notin \{0, 1\}$, are removed from the bit sequence. Bit $f_{i,1}$ corresponds to the bit $z_{i,k}$ with smallest index k after puncturing, bit $f_{i,2}$ corresponds to the bit $z_{i,k}$ with second smallest index k after puncturing, and so on.

For convolutionally encoded TrCHs and turbo encoded TrCHs with repetition:

$$z_{i,k} = y_{1,i,k} \qquad k = 1, 2, 3, \ldots, Y_i$$

When repetition is used, $f_{i,k}=z_{i,k}$ and $Y_i=V_i$.

When puncturing is used, $Y_i=X_i$ and bits $z_{i,k}$ with value δ, where $\delta \notin \{0, 1\}$, are removed from the bit sequence. Bit $f_{i,1}$ corresponds to the bit $z_{i,k}$ with smallest index k after puncturing, bit $f_{i,2}$ corresponds to the bit $z_{i,k}$ with second smallest index k after puncturing, and so on.

4.2.7.4 Bit separation and collection in downlink

The systematic bits of turbo encoded TrCHs shall not be punctured, the other bits may be punctured.

The systematic bits, first parity bits and second parity bits in the bit sequence input to the rate matching block are therefore separated into three sequences of equal lengths.

The first sequence contains :

- All of the systematic bits that are from turbo encoded TrCHs.
- Some of the systematic, first parity and second parity bits that are for trellis termination.

The second sequence contains:

- All of the first parity bits that are from turbo encoded TrCHs.
- Some of the systematic, first parity and second parity bits that are for trellis termination.

The third sequence contains:

- All of the second parity bits that are from turbo encoded TrCHs.
- Some of the systematic, first parity and second parity bits that are for trellis termination.

Puncturing is applied only to the second and third sequences.

The bit separation function is transparent for convolutionally encoded TrCHs and for turbo encoded TrCHs with repetition. The bit separation and bit collection are illustrated in figures 7 and 8.

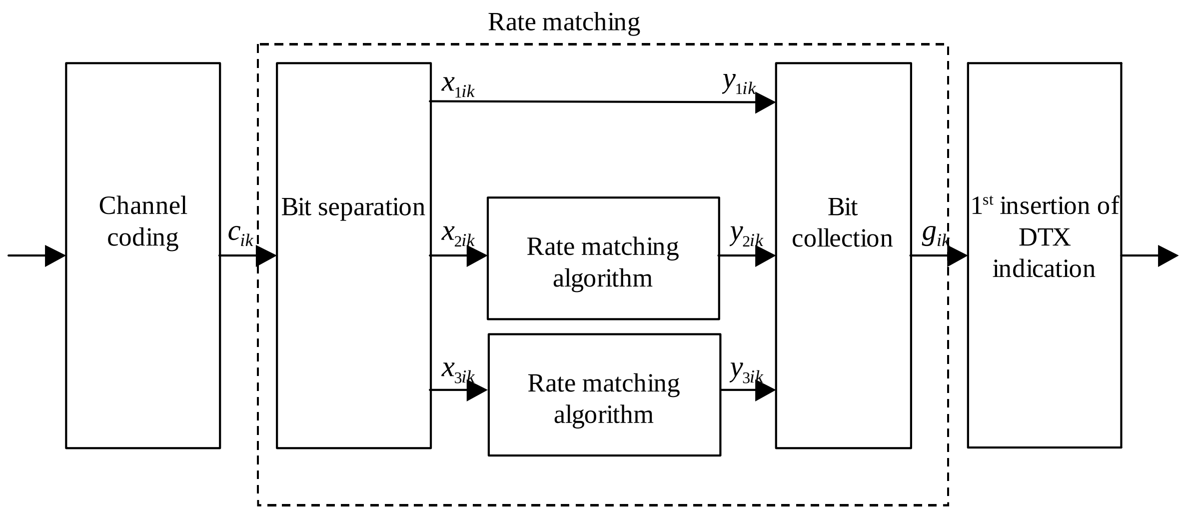


Figure 7: Puncturing of turbo encoded TrCHs in downlink

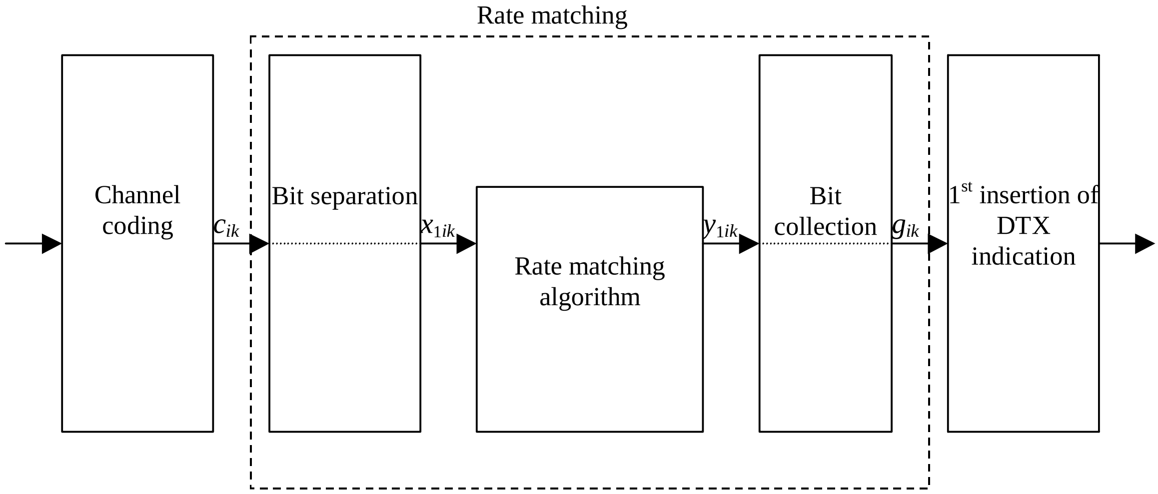


Figure 8: Rate matching for convolutionally encoded TrCHs and for turbo encoded TrCHs with repetition in downlink

4.2.7.4.1 Bit separation

The bits input to the rate matching are denoted by $c_{i1}, c_{i2}, c_{i3}, \ldots, c_{iE_i}$, where *i* is the TrCH number and E_i is the number of bits input to the rate matching block. Note that E_i is a multiple of 3 for turbo encoded TrCHs and that the transport format *l* for simplicity has been left out in the bit numbering, i.e. $E_i = N_{il}^{TTI}$. The bits after separation are denoted by $x_{bi1}, x_{bi2}, x_{bi3}, \ldots, x_{biX_i}$. For turbo encoded TrCHs with puncturing, *b* indicates the three sequences defined in section 4.2.7.4, with b=1 indicating the first sequence, and so forth. For all other cases *b* is defined to be 1. X_i is the number of bits in each separated bit sequence. The relation between c_{ik} and x_{bik} is given below.

For turbo encoded TrCHs with puncturing:

$x_{1,i,k} = c_{i,3(k-1)+1}$ k = 1, 2, 3, …, X_i $X_i = E_i/3$

$x_{2,i,k} = c_{i,3(k-1)+2}$ k = 1, 2, 3, …, X_i $X_i = E_i/3$

$x_{3,i,k} = c_{i,3(k-1)+3}$ k = 1, 2, 3, …, X_i $X_i = E_i/3$

For convolutionally encoded TrCHs and turbo encoded TrCHs with repetition:

$x_{1,i,k} = c_{i,k}$ k = 1, 2, 3, …, X_i $X_i = E_i$

4.2.7.4.2 Bit collection

The bits x_{bik} are input to the rate matching algorithm described in subclause 4.2.7.5. The bits output from the rate matching algorithm are denoted $y_{bi1}, y_{bi2}, y_{bi3}, \ldots, y_{biY_i}$.

Bit collection is the inverse function of the separation. The bits after collection are denoted by $z_{bi1}, z_{bi2}, z_{bi3}, \ldots, z_{biY_i}$. After bit collection, the bits indicated as punctured are removed and the bits are then denoted by $g_{i1}, g_{i2}, g_{i3}, \ldots, g_{iG_i}$, where *i* is the TrCH number and $G_i = N_{il}^{TTI} + \Delta N_{il}^{TTI}$. The relations between y_{bik}, z_{bik}, and g_{ik} are given below.

For turbo encoded TrCHs with puncturing ($Y_i = X_i$):

$z_{i,3(k-1)+1} = y_{1,i,k}$ k = 1, 2, 3, …, Y_i

$z_{i,3(k-1)+2} = y_{2,i,k}$ k = 1, 2, 3, …, Y_i

$z_{i,3(k-1)+3} = y_{3,i,k}$ k = 1, 2, 3, …, Y_i

After the bit collection, bits $z_{i,k}$ with value δ, where $\delta \notin \{0, 1\}$, are removed from the bit sequence. Bit $g_{i,1}$ corresponds to the bit $z_{i,k}$ with smallest index k after puncturing, bit $g_{i,2}$ corresponds to the bit $z_{i,k}$ with second smallest index k after puncturing, and so on.

For convolutionally encoded TrCHs and turbo encoded TrCHs with repetition:

$z_{i,k} = y_{1,i,k}$ k = 1, 2, 3, …, Y_i

When repetition is used, $g_{i,k}=z_{i,k}$ and $Y_i=G_i$.

When puncturing is used, $Y_i=X_i$ and bits $z_{i,k}$ with value δ, where $\delta \notin \{0, 1\}$, are removed from the bit sequence. Bit $g_{i,1}$ corresponds to the bit $z_{i,k}$ with smallest index k after puncturing, bit $g_{i,2}$ corresponds to the bit $z_{i,k}$ with second smallest index k after puncturing, and so on.

4.2.7.5 Rate matching pattern determination

Denote the bits before rate matching by:

$x_{i1}, x_{i2}, x_{i3}, \ldots, x_{iX_i}$, where i is the TrCH number and the sequence is defined in 4.2.7.3 for uplink or in 4.2.7.4 for downlink. Parameters X_i, e_{ini}, e_{plus}, and e_{minus} are given in 4.2.7.1 for uplink or in 4.2.7.2 for downlink.

The rate matching rule is as follows:

```
if puncturing is to be performed
    e = e_ini        -- initial error between current and desired puncturing ratio
    m = 1            -- index of current bit
    do while m <= X_i
        e = e – e_minus        -- update error
        if e <= 0 then         -- check if bit number m should be punctured
            set bit x_i,m to δ where δ ∉ {0, 1}
            e = e + e_plus   -- update error
        end if
        m = m + 1              --   next bit
    end do
else
    e = e_ini              -- initial error between current and desired puncturing ratio
    m = 1                  -- index of current bit
    do while m <= X_i
        e = e – e_minus        -- update error
        do while e <= 0        -- check if bit number m should be repeated
            repeat bit x_i,m
            e = e +   e_plus -- update error
```

end do

m = m + 1 -- *next bit*

end do

end if

A repeated bit is placed directly after the original one.

4.2.8 TrCH multiplexing

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).

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:

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

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

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

$\ldots$

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

4.2.9 Insertion of discontinuous transmission (DTX) indication bits

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

4.2.9.1 1st insertion of DTX indication bits

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

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

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

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

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

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

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

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

4.2.9.2 2nd insertion of DTX indication bits

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

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

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

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

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

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

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

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

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

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

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

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

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

$w_k = s_k$ k = 1, 2, 3, …, S

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

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

4.2.10 Physical channel segmentation

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

The bits after physical channel segmentation are denoted $u_{p,1}, u_{p,2}, u_{p,3}, \ldots, u_{p,U}$, where p is PhCH number and U is the number of bits in one radio frame for each PhCH, i.e. ~~$U = (X - N_{TGL} - (N_{data,*} - N'_{data,*}))/P$ for compressed mode by puncturing, and~~ $U = \frac{X}{P}$ ~~otherwise~~. The relation between x_k and $u_{p,k}$ is given below.

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

Bits on first PhCH after physical channel segmentation:

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

Bits on second PhCH after physical channel segmentation:

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

…

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

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

~~where f is such that :~~

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

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

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

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

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

4.2.11 2nd interleaving

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

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

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

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

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

(3) Write the input bit sequence $u_{p,1}, u_{p,2}, u_{p,3}, \ldots, u_{p,U}$ into the R2 × C2 matrix row by row starting with bit $y_{p,1}$ in column 0 of row 0:

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

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

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

$$\begin{bmatrix} y'_{p,1} & y'_{p,(\text{R2}+1)} & y'_{p,(2\times\text{R2}+1)} & \ldots & y'_{p,((\text{C2-1})\times\text{R2}+1)} \\ y'_{p,2} & y'_{p,(\text{R2}+2)} & y'_{p,(2\times\text{R2}+2)} & \ldots & y'_{p,((\text{C2-1})\times\text{R2}+2)} \\ \vdots & \vdots & \vdots & \ldots & \vdots \\ y'_{p,\text{R2}} & y'_{p,(2\times\text{R2})} & y'_{p,(3\times\text{R2})} & \ldots & y'_{p,(\text{C2}\times\text{R2})} \end{bmatrix}$$

(5) The output of the block interleaver is the bit sequence read out column by column from the inter-column permuted R2 × C2 matrix. The output is pruned by deleting dummy bits that were padded to the input of the matrix before the inter-column permutation, i.e. bits $y'_{p,k}$ that corresponds to bits $y_{p,k}$ with *k*>*U* are removed from the output. The bits after 2nd interleaving are denoted by $v_{p,1}, v_{p,2}, \ldots, v_{p,U}$, where $v_{p,1}$ corresponds to the bit $y'_{p,k}$ with smallest index *k* after pruning, $v_{p,2}$ to the bit $y'_{p,k}$ with second smallest index *k* after pruning, and so on.

Table 7 Inter-column permutation pattern for 2nd interleaving

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

4.2.12 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 $v_{p,1}, v_{p,2}, \ldots, v_{p,U}$, where *p* is the PhCH number and *U* is the number of bits in one radio frame for one PhCH. The bits $v_{p,k}$ are mapped to the PhCHs so that the bits for each PhCH are transmitted over the air in ascending order with respect to *k*.

In compressed mode, no bits are mapped to certain slots of the PhCH(s). If $N_{first} + TGL \le 15$, no bits are mapped to slots N_{first} to N_{last}. If $N_{first} + TGL > 15$, i.e. the transmission gap spans two consecutive radio frames, the mapping is as follows:

- In the first radio frame, no bits are mapped to slots N_{first}, $N_{first}+1$, $N_{first}+2$, …, 14.
- In the second radio frame, no bits are mapped to the slots 0, 1, 2, …, N_{last}.

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

4.2.12.1 Uplink

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. The only exception is when the UE is in compressed mode. The transmission can then be turned off during consecutive slots of the radio frame.

4.2.12.2 Downlink

In downlink, the PhCHs do not need to be completely filled with bits that are transmitted over the air. Values $v_{p,k} \notin \{0, 1\}$ correspond to DTX indicators, which are mapped to the DPCCH/DPDCH fields but are not transmitted over the air.

During compressed mode by reducing the spreading factor by 2, the data bits are always mapped into 7.5 slots within a compressed frame. No bits are mapped to the DPDCH field as follows:

If $N_{first} + TGL \le 15$, i.e. the transmission gap spans one radio frame,

if $N_{first} + 7 \le 14$

no bits are mapped to slots $N_{first}, N_{first} + 1, N_{first} + 2, \ldots, N_{first} + 6$

no bits are mapped to the first $(N_{Data1} + N_{Data2})/2$ bit positions of slot $N_{first}+7$

else

no bits are mapped to slots $N_{first}, N_{first} + 1, N_{first} + 2, \ldots, 14$

no bits are mapped to slots $N_{first} - 1, N_{first} - 2, N_{first} - 3, \ldots, 8$

no bits are mapped to the last $(N_{Data1} + N_{Data2})/2$ bit positions of slot 7

end if

If $N_{first} + TGL > 15$, i.e. the transmission gap spans two consecutive radio frames,

In the first radio frame, no bits are mapped to last $(N_{Data1} + N_{Data2})/2$ bit positions in slot 7 as well as to slots 8, 9, 10, ..., 14.

In the second radio frame, no bits are mapped to slots 0, 1, 2, ..., 6 as well as to first $(N_{Data1} + N_{Data2})/2$ bit positions in slot 7.

N_{Data1} and N_{Data2} are defined in [2].

4.2.13 Restrictions on different types of CCTrCHs

Restrictions on the different types of CCTrCHs are described in general terms in TS 25.302[11]. In this subclause those restrictions are given with layer 1 notation.

4.2.13.1 Uplink Dedicated channel (DCH)

The maximum value of the number of TrCHs *I* in a CCTrCH, the maximum value of the number of transport blocks M_i on each transport channel, and the maximum value of the number of DPDCHs *P* are given from the UE capability class.

4.2.13.2 Random Access Channel (RACH)

- There can only be one TrCH in each RACH CCTrCH, i.e. I=1, $s_k = f_{1k}$ and $S = V_1$.
- The maximum value of the number of transport blocks M_1 on the transport channel is given from the UE capability class.
- The transmission time interval is either 10 ms or 20 ms.
- Only one PRACH is used, i.e. P=1, $u_{1k} = s_k$, and $U = S$.
- The Static rate matching parameter RM_1 is not provided by higher layer signalling on the System information as the other transport channel parameters. Any value may be used as there is one transport channel in the CCTrCH, hence one transport channel per Transport Format Combination and no need to do any balancing between multiple transport channels.

4.2.13.3 Common Packet Channel (CPCH)

- There can only be one TrCH in each CPCH CCTrCH, i.e. I=1, $s_k = f_{1k}$ and $S = V_1$.
- The maximum value of the number of transport blocks M_1 on the transport channel is given from the UE capability class.
- Only one PCPCH is used, i.e. P=1, $u_{1k} = s_k$, and $U = S$.

4.2.13.4 Downlink Dedicated Channel (DCH)

The maximum value of the number of TrCHs I in a CCTrCH, the maximum value of the number of transport blocks M_i on each transport channel, and the maximum value of the number of DPDCHs P are given from the UE capability class.

4.2.13.5 Downlink Shared Channel (DSCH) associated with a DCH

- The spreading factor is indicated with the TFCI of the associated DPCH.
- The maximum value of the number of TrCHs I in a CCTrCH, the maximum value of the number of transport blocks M_I on the transport channel and the maximum value of the number of PDSCHs P are given from the UE capability class.

4.2.13.6 Broadcast channel (BCH)

- There can only be one TrCH in the BCH CCTrCH, i.e. I=1, $s_k = f_{1k}$, and $S = V_1$.
- There can only be one transport block in each transmission time interval, i.e. M_1 = 1.
- All transport format attributes have predefined values which are provided in [11] apart from the rate matching RM_1.
- The Static rate matching parameter RM_1 is not provided by higher layer signalling neither fixed. Any value may be used as there is one transport channel in the CCTrCH, hence one transport channel per Transport Format Combination and no need to do any balancing between multiple transport channels.
- Only one primary CCPCH is used, i.e. P=1.

4.2.13.7 Forward access and paging channels (FACH and PCH)

- The maximum value of the number of TrCHs I in a CCTrCH and the maximum value of the number of transport blocks M_i on each transport channel are given from the UE capability class.
- The transmission time interval for TrCHs of PCH type is always 10 ms.
- Only one secondary CCPCH is used per CCTrCH, i.e. P=1.

4.2.13.8 High Speed Downlink Shared Channel (HS-DSCH) associated with a DCH

- There can be only one TrCH in the HS-DSCH CCTrCH, i.e. $I = 1$,
- There can only be one transport block in each transmission time interval, i.e. $M_1 = 1$.
- The transmission time interval for TrCHs of HS-DSCH type is always 2 ms.
- The maximum value of the number of HS-PDSCHs P are given from the UE capability class.

4.2.14 Multiplexing of different transport channels into one CCTrCH, and mapping of one CCTrCH onto physical channels

The following rules shall apply to the different transport channels which are part of the same CCTrCH:

1) Transport channels multiplexed into one CCTrCh shall have co-ordinated timings. When the TFCS of a CCTrCH is changed because one or more transport channels are added to the CCTrCH or reconfigured within the CCTrCH, or removed from the CCTrCH, the change may only be made at the start of a radio frame with CFN fulfilling the relation

   CFN mod F_{max} = 0,

   where F_{max} denotes the maximum number of radio frames within the transmission time intervals of all transport channels which are multiplexed into the same CCTrCH, including any transport channels *i* which are added, reconfigured or have been removed, and CFN denotes the connection frame number of the first radio frame of the changed CCTrCH.

   After addition or reconfiguration of a transport channel *i* within a CCTrCH, the TTI of transport channel *i* may only start in radio frames with CFN fulfilling the relation:

   CFN mod F_i = 0.

   For a CCTrCH of DSCH type, a modification of number of bits $N_{data,*}$ allocated on a radio frame is allowed if the CFN verifies CFN mod F_{max} = 0, where F_{max} denotes the maximum number of radio frames within the transmission time intervals of all the transport channels with a non zero transport block transport format multiplexed into the CCTrCH in the previous radio frame.

2) Only transport channels with the same active set can be mapped onto the same CCTrCH.
3) Different CCTrCHs cannot be mapped onto the same PhCH.
4) One CCTrCH shall be mapped onto one or several PhCHs. These physical channels shall all have the same SF.
5) Dedicated Transport channels and common transport channels cannot be multiplexed into the same CCTrCH.
6) For the common transport channels, only the FACH and PCH may belong to the same CCTrCH.

There are hence two types of CCTrCH:

1) CCTrCH of dedicated type, corresponding to the result of coding and multiplexing of one or several DCHs.
2) CCTrCH of common type, corresponding to the result of the coding and multiplexing of a common channel, RACH in the uplink, DSCH, HS-DSCH, BCH, or FACH/PCH for the downlink.

4.2.14.1 Allowed CCTrCH combinations for one UE

4.2.14.1.1 Allowed CCTrCH combinations on the uplink

A maximum of one CCTrCH is allowed for one UE on the uplink. It can be either:

1) one CCTrCH of dedicated type;
2) one CCTrCH of common type.

4.2.14.1.2 Allowed CCTrCH combinations on the downlink

The following CCTrCH combinations for one UE are allowed:

- x CCTrCH of dedicated type + y CCTrCH of common type. The allowed combination of CCTrCHs of dedicated and common type are given from UE radio access capabilities. There can be a maximum of one CCTrCH of common type for DSCH or HS-DSCH and a maximum of one CCTrCH of common type for FACH. With one CCTrCH of common type for DSCH or HS-DSCH, there shall be only one CCTrCH of dedicated type.

NOTE 1: There is only one DPCCH in the uplink, hence one TPC bits flow on the uplink to control possibly the different DPDCHs on the downlink, part of the same or several CCTrCHs.

NOTE 2: There is only one DPCCH in the downlink, even with multiple CCTrCHs. With multiple CCTrCHs, the DPCCH is transmitted on one of the physical channels of that CCTrCH which has the smallest SF among the multiple CCTrCHs. Thus there is only one TPC command flow and only one TFCI word in downlink even with multiple CCTrCHs.

NOTE 3: in the current release, only 1 CCTrCH of dedicated type is supported.

4.3 Transport format detection

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

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

If the transport format set for a TrCH *i* does not contain more than one transport format with more than zero transport blocks, no explicit blind transport format detection needs to be performed for this TrCH. The UE can use guided detection for this TrCH or single transport format detection, where the UE always assumes the transport format corresponding to more than zero transport blocks for decoding.

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

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

4.3.1 Blind transport format detection

When no TFCI is available then explicit blind detection or guided detection shall be performed on all TrCHs within the CCTrCH that have more than one transport format and that do not use single transport format detection. The UE shall only be required to support blind transport format detection if all of the following restrictions are fulfilled:

1. either only one CCTrCH is received, or one CCTrCH of dedicated type and one CCTrCH of common type for HS-DSCH are received by the UE;

   If only one CCTrCH is received by the UE, the following conditions apply to that CCTrCH and those TrCHs that are multiplexed on the CCTrCH. If one CCTrCH of dedicated type and one CCTrCH of common type for HS-DSCH are received by the UE, the following conditions apply to the dedicated type CCTrCH and the TrCHs that are multiplexed on the dedicated type CCTrCH.

2. the number of CCTrCH bits received per radio frame is 600 or less;

3. the number of transport format combinations of the CCTrCH is 64 or less;
4. fixed positions of the transport channels is used on the CCTrCH to be detectable;
5. convolutional coding is used on all explicitly detectable TrCHs;
6. CRC with non-zero length is appended to all transport blocks on all explicitly detectable TrCHs;
7. at least one transport block shall be transmitted per TTI on each explicitly detectable TrCH;
8. the number of explicitly detectable TrCHs is 3 or less;
9. for all explicitly detectable TrCHs *i*, the number of code blocks in one TTI (C_i) shall not exceed 1;
10. the sum of the transport format set sizes of all explicitly detectable TrCHs, is 16 or less. The transport format set size is defined as the number of transport formats within the transport format set;
11. there is at least one TrCH that can be used as the guiding transport channel for all transport channels using guided detection.

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

4.3.1a Single transport format detection

When no TFCI is available, then single transport format detection shall be applied on all TrCHs within the CCTrCH that have a transport format set not containing more than one transport format with more than zero transport blocks and that do not use guided detection. The UE shall only be required to support single transport format detection if the following restrictions are fulfilled:

1. For each transport channel that is single transport format detected, CRC with non-zero length is appended to all transport blocks within the non-zero transport block transport format;
2. fixed positions of the transport channels is used on the CCTrCH to be detectable.

4.3.2 Transport format detection based on TFCI

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

4.3.3 Coding of Transport-Format-Combination Indicator (TFCI)

The TFCI is encoded using a (32, 10) sub-code of the second order Reed-Muller code. The coding procedure is as shown in figure 9.

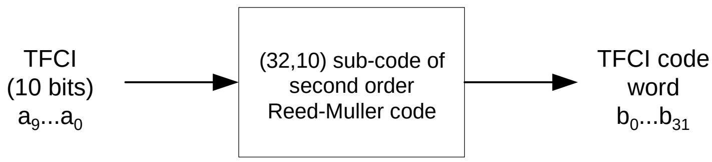


Figure 9: Channel coding of TFCI information bits

If the TFCI consist of less than 10 bits, it is padded with zeros to 10 bits, by setting the most significant bits to zero. The length of the TFCI code word is 32 bits.

The code words of the (32,10) sub-code of second order Reed-Muller code are linear combination of 10 basis sequences. The basis sequences are as in the following table 8.

Table 8: Basis sequences for (32,10) TFCI code

i	$M_{i,0}$	$M_{i,1}$	$M_{i,2}$	$M_{i,3}$	$M_{i,4}$	$M_{i,5}$	$M_{i,6}$	$M_{i,7}$	$M_{i,8}$	$M_{i,9}$
0	1	0	0	0	0	1	0	0	0	0
1	0	1	0	0	0	1	1	0	0	0
2	1	1	0	0	0	1	0	0	0	1
3	0	0	1	0	0	1	1	0	1	1
4	1	0	1	0	0	1	0	0	0	1
5	0	1	1	0	0	1	0	0	1	0
6	1	1	1	0	0	1	0	1	0	0
7	0	0	0	1	0	1	0	1	1	0
8	1	0	0	1	0	1	1	1	1	0
9	0	1	0	1	0	1	1	0	1	1
10	1	1	0	1	0	1	0	0	1	1
11	0	0	1	1	0	1	0	1	1	0
12	1	0	1	1	0	1	0	1	0	1
13	0	1	1	1	0	1	1	0	0	1
14	1	1	1	1	0	1	1	1	1	1
15	1	0	0	0	1	1	1	1	0	0
16	0	1	0	0	1	1	1	1	0	1
17	1	1	0	0	1	1	1	0	1	0
18	0	0	1	0	1	1	0	1	1	1
19	1	0	1	0	1	1	0	1	0	1
20	0	1	1	0	1	1	0	0	1	1
21	1	1	1	0	1	1	0	1	1	1
22	0	0	0	1	1	1	0	1	0	0
23	1	0	0	1	1	1	1	1	0	1
24	0	1	0	1	1	1	1	0	1	0
25	1	1	0	1	1	1	1	0	0	1
26	0	0	1	1	1	1	0	0	1	0
27	1	0	1	1	1	1	1	1	0	0
28	0	1	1	1	1	1	1	1	1	0
29	1	1	1	1	1	1	1	1	1	1
30	0	0	0	0	0	1	0	0	0	0
31	0	0	0	0	1	1	1	0	0	0

The TFCI information bits a_0 , a_1 , a_2 , a_3 , a_4 , a_5 , a_6 , a_7 , a_8 , a_9 (where a_0 is LSB and a_9 is MSB) shall correspond to the TFC index (expressed in unsigned binary form) defined by the RRC layer to reference the TFC of the CCTrCH in the associated DPCH radio frame.

The output code word bits b_i are given by:

$$b_i = \sum_{n=0}^{9} (a_n \times M_{i,n}) \bmod 2$$

where i = 0, …, 31.

The output bits are denoted by b_k, k = 0, 1, 2, …, 31.

In downlink, when the SF < 128 the encoded TFCI code words are repeated yielding 8 encoded TFCI bits per slot in normal mode and 16 encoded TFCI bits per slot in compressed mode. Mapping of repeated bits to slots is explained in subclause 4.3.5.

4.3.4 Operation of TFCI in Hard Split Mode

If one of the DCH is associated with a DSCH, the TFCI code word may be split in such a way that the code word relevant for TFCI activity indication is not transmitted from every cell. The use of such a functionality shall be indicated by higher layer signalling.

The TFCI is encoded by using punctured code of (32,10) sub-code of second order Reed-Muller code. The coding procedure is as shown in figure 10.

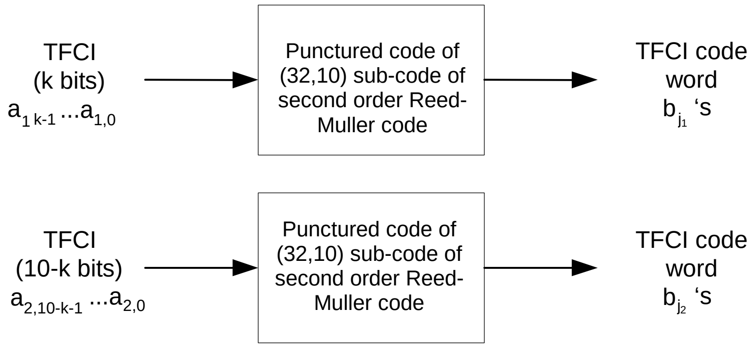


Figure 10: Channel coding of flexible hard split mode TFCI information bits

The code words of the punctured code of (32,10) sub-code of second order Reed-Muller code are linear combinations of basis sequences generated by puncturing 10 basis sequences defined in table 8 in section 4.3.3.

The first set of TFCI information bits ($a_{1,0}$, $a_{1,1}$, $a_{1,2}$, $a_{1,3}$, …, $a_{1,k-1}$ where $a_{1,0}$ is LSB and $a_{1,k-1}$ is MSB) shall correspond to the TFC index (expressed in unsigned binary form) defined by the RRC layer to reference the TFC of the DCH CCTrCH in the associated DPCH radio frame.

The second set of TFCI information bits ($a_{2,0}$, $a_{2,1}$, $a_{2,2}$, $a_{2,3}$, .., $a_{2,10-k-1}$ where $a_{2,0}$ is LSB and $a_{2,10-k-1}$ is MSB) shall correspond to the TFC index (expressed in unsigned binary form) defined by the RRC layer to reference the TFC of the associated DSCH CCTrCH in the corresponding PDSCH radio frame.

The output code word bits are given by :

$$b_{j_1} = \sum_{n=0}^{k-1} (a_{1,n} \times M_{\pi_1(k,i_1),\pi_2(k,n)}) \bmod 2 ; \qquad b_{j_2} = \sum_{n=0}^{10-k-1} (a_{2,n} \times M_{\pi_1(10-k,i_2),\pi_2(10-k,n)}) \bmod 2$$

where $i_1 = 0, \ldots, 3\times k$ and $i_2 = 0, \ldots, 30-3\times k$.

Then, the relation between j_1 (or j_2) and i_1 (or i_2) is as follows:

$$j_1 = \left\lfloor \frac{32}{3\times k+1} \times (i_1 + 1 - \frac{1}{2}\left\lfloor \frac{k}{5} \right\rfloor) + \frac{1}{2} \right\rfloor - 1 ; \qquad j_2 = \left\lfloor \frac{32}{32-(3\times k+1)} \times (i_2 + \frac{1}{2}\left(1 + \left\lfloor \frac{k}{5} \right\rfloor\right)) + \frac{1}{2} \right\rfloor - 1 .$$

The functions π_1, π_2 are defined as shown in the following table 9.

Table 9. π_1, π_2 functions

m	$\pi_1(m,i)$ **for i = 0, …, 3×m**	$\pi_2(m,n)$ **for n = 0,…, m-1**
3	0, 1, 2, 3, 4, 5, 6, 8, 9, 11	0, 1, 2
4	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	0, 1, 2, 3
5	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 30	0, 1, 2, 3, 5
6	0, 1, 2, 3, 4, 5, 7, 8, 9, 12, 15, 18, 21, 23, 25, 27, 28, 29, 30	0, 1, 2, 3, 4, 5
7	0, 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 13, 14, 15, 17, 20, 21, 22, 24, 25, 28, 29	0, 1, 2, 3, 4, 6, 7

4.3.5 Mapping of TFCI words

4.3.5.1 Mapping of TFCI word in normal mode

The bits of the code word are directly mapped to the slots of the radio frame. Within a slot the bit with lower index is transmitted before the bit with higher index. The coded bits b_k, are mapped to the transmitted TFCI bits d_k, according to the following formula:

$$d_k = b_{k \bmod 32}$$

For uplink physical channels regardless of the SF and downlink physical channels, if SF≥128, $k = 0, 1, 2, \ldots, 29$. Note that this means that bits b_{30} and b_{31} are not transmitted.

For downlink physical channels whose SF < 128, $k = 0, 1, 2, \ldots, 119$. Note that this means that bits b_0 to b_{23} are transmitted four times and bits b_{24} to b_{31} are transmitted three times.

4.3.5.2 Mapping of TFCI word in compressed mode

The mapping of the TFCI bits in compressed mode is different for uplink, downlink with SF ≥ 128 and downlink with SF < 128.

4.3.5.2.1 Uplink compressed mode

For uplink compressed mode, the slot format is changed so that no TFCI coded bits are lost. The different slot formats in compressed mode do not match the exact number of TFCI coded bits for all possible TGLs. Repetition of the TFCI bits is therefore used.

Denote the number of bits available in the TFCI fields of one compressed radio frame by D and the number of bits in the TFCI field in a slot by N_{TFCI}. The parameter E is used to determine the number of the first TFCI bit to be repeated.

$E = N_{first} N_{TFCI}$, if the start of the transmission gap is allocated to the current frame.
$E = 0$, if the start of the transmission gap is allocated to the previous frame and the end of the transmission gap is allocated to the current frame.

The TFCI coded bits b_k are mapped to the bits in the TFCI fields d_k. The following relations define the mapping for each compressed frame.

$$d_k = b_k$$

where $k = 0, 1, 2, \ldots, \min(31, D-1)$.

If $D > 32$, the remaining positions are filled by repetition (in reversed order):

$$d_{D-k-1} = b_{(E+k) \bmod 32}$$

where $k = 0, \ldots, D-33$.

4.3.5.2.2 Downlink compressed mode

For downlink compressed mode, the slot format is changed so that no TFCI coded bits are lost. The different slot formats in compressed mode do not match the exact number of TFCI bits for all possible TGLs. DTX is therefore used if the number of bits available in the TFCI fields in one compressed frame exceeds the number of TFCI bits given from the slot format. The block of bits in the TFCI fields where DTX is used starts on the first TFCI field after the transmission gap. If there are more bits available in the TFCI fields before the transmission gap than TFCI bits, DTX is also used on the bits in the last TFCI fields before the transmission gap.

Denote the number of bits available in the TFCI fields of one compressed radio frame by D and the number of bits in the TFCI field in a slot by N_{TFCI}. The parameter E is used to determine the position of the first bit in the TFCI field on which DTX is used.

$E = N_{first} N_{TFCI}$, if the start of the transmission gap is allocated to the current frame.
$E = 0$, if the start of the transmission gap is allocated to the previous frame and the end of the transmission gap is allocated to the current frame.

Denote the total number of TFCI bits to be transmitted by F. F = 32 for slot formats nA or nB, where n = 0, 1, …, 11 (see table 11 in [2]). Otherwise, F = 128. The TFCI coded bits b_k are mapped to the bits in the TFCI fields d_k. The following relations define the mapping for each compressed frame.

If $E > 0$,

$$d_k = b_{k \bmod 32}$$

where k = 0, 1, 2, …, min (E, F)-1.

If $E < F$,

$$d_{k+D-F} = b_{k \bmod 32}$$

where $k = E, ..., F -1$.

DTX is used on d_k where k = min (E, F), ..., min (E, F) +D - F -1.

4.4 Compressed mode

In compressed frames, TGL slots from N_{first} to N_{last} are not used for transmission of data. As illustrated in figure 11, the instantaneous transmit power is increased in the compressed frame in order to keep the quality (BER, FER, etc.) unaffected by the reduced processing gain. The amount of power increase depends on the transmission time reduction method (see subclause 4.4.3). What frames are compressed, are decided by the network. When in compressed mode, compressed frames can occur periodically, as illustrated in figure 11, or requested on demand. The rate and type of compressed frames is variable and depends on the environment and the measurement requirements.

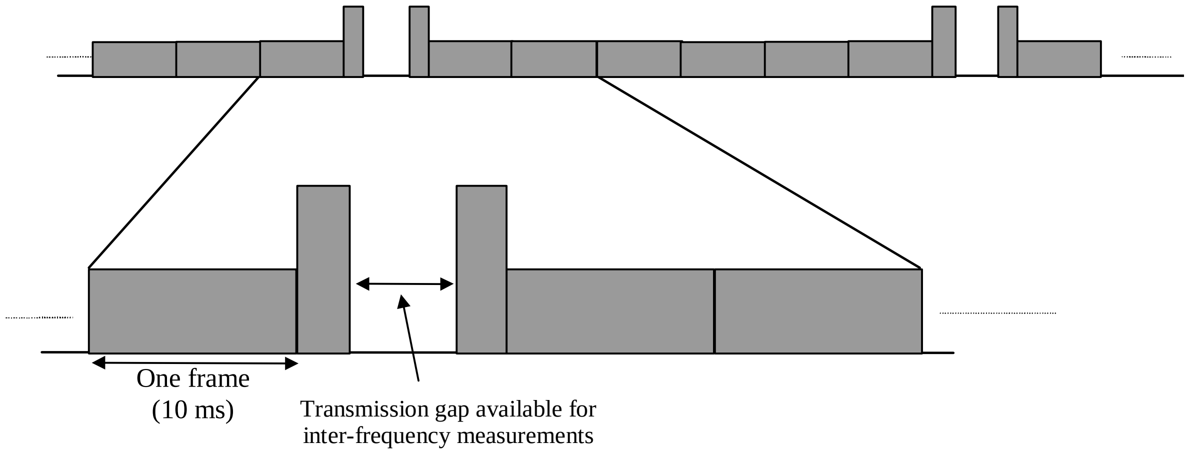


Figure 11: Compressed mode transmission

4.4.1 Frame structure in the uplink

The frame structure for uplink compressed frames is illustrated in figure 12.

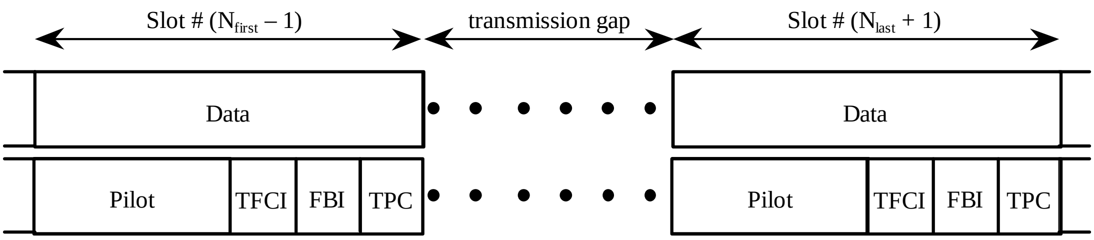


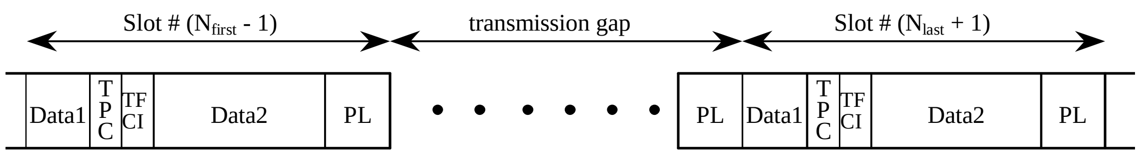
Figure 12: Frame structure in uplink compressed transmission

4.4.2 Frame structure types in the downlink

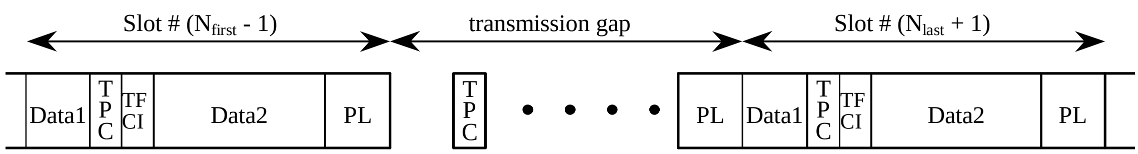
There are two different types of frame structures defined for downlink compressed frames. Type A maximises the transmission gap length and type B is optimised for power control. The frame structure type A or B is set by higher layers independent from the downlink slot format type A or B.

- With frame structure of type A, the pilot field of the last slot in the transmission gap is transmitted. Transmission is turned off during the rest of the transmission gap (figure 13(a)). In case the length of the pilot field is 2 bits and STTD is used on the radio link, the pilot bits in the last slot of the transmission gap shall be STTD encoded assuming DTX indicators as the two last bits in the Data2 field.

- With frame structure of type B, the TPC field of the first slot in the transmission gap and the pilot field of the last slot in the transmission gap is transmitted. Transmission is turned off during the rest of the transmission gap (figure 13(b)). In case the length of the pilot field is 2 bits and STTD is used on the radio link, the pilot bits in the last slot of the transmission gap shall be STTD encoded assuming DTX indicators as the two last bits of the Data2 field. Similarly, the TPC bits in the first slot of the transmission gap shall be STTD encoded assuming DTX indicators as the two last bits in the Data1 field.



(a) Frame structure type A



(b) Frame structure type B

Figure 13: Frame structure types in downlink compressed transmission

4.4.3 Transmission time reduction method

When in compressed mode, the information normally transmitted during a 10 ms frame is compressed in time. The mechanisms provided for achieving this are ~~puncturing,~~ reduction of the spreading factor by a factor of two , and higher layer scheduling. In the downlink and the uplink, all methods are supported ~~while compressed mode by puncturing is not used in the uplink~~. The maximum idle length is defined to be 7 slots per one 10 ms frame. The slot formats that are used in compressed frames are listed in [2].

4.4.3.1 ~~Compressed mode by puncturing~~Void

~~Rate matching is applied for creating a transmission gap in one or two frames. The algorithm for rate matching as described in subclause 4.2.7 is used.~~

Annex B (informative): Compressed mode idle lengths

The tables B.1-B.3 show the resulting idle lengths for different transmission gap lengths, UL/DL modes and DL frame types. The idle lengths given are calculated purely from the slot and frame structures and the UL/DL offset. They do not contain margins for e.g. synthesizer switching.

B.1 Idle lengths for DL, UL and DL+UL compressed mode

Table B.1: Parameters for DL compressed mode

TGL	DL Frame Type	Spreading Factor	Idle length [ms]	Transmission time Reduction method	Idle frame Combining
3	A	512 – 4	1.73 – 1.99	~~Puncturing,~~ Spreading factor division by 2 or Higher layer scheduling	(S) (D) =(1,2) or (2,1)
	B		1.60 – 1.86		
4	A		2.40 – 2.66		(S) (D) =(1,3), (2,2) or (3,1)
	B		2.27 – 2.53		
5	A		3.07 – 3.33		(S) (D) = (1,4), (2,3), (3, 2) or (4,1)
	B		2.93 – 3.19		
7	A		4.40 – 4.66		(S) (D)=(1,6), (2,5), (3,4), (4,3), (5,2) or (6,1)
	B		4.27 – 4.53		
10	A		6.40 – 6.66		(D)=(3,7), (4,6), (5,5), (6,4) or (7,3)
	B		6.27 – 6.53		
14	A		9.07 – 9.33		(D) =(7,7)
	B		8.93 – 9.19		

Table B.2: Parameters for UL compressed mode

TGL	Spreading Factor	Idle length [ms]	Transmission time Reduction method	Idle frame Combining
3	256 – 4	2.00	Spreading factor division by 2 or Higher layer scheduling	(S) (D) =(1,2) or (2,1)
4		2.67		(S) (D) =(1,3), (2,2) or (3,1)
5		3.33		(S) (D) = (1,4), (2,3), (3, 2) or (4,1)
7		4.67		(S) (D)=(1,6), (2,5), (3,4), (4,3), (5,2) or (6,1)
10		6.67		(D)=(3,7), (4,6), (5,5), (6,4) or (7,3)
14		9.33		(D) =(7,7)

Table B.3: Parameters for combined UL/DL compressed mode

TGL	DL Frame Type	Spreading Factor	Idle length [ms]	Transmission time Reduction method	Idle frame Combining
3	A or B	DL: 512 – 4 UL: 256 – 4	1.47 – 1.73	~~DL: Puncturing,~~ Spreading factor division by 2 or Higher layer scheduling ~~UL: Spreading factor division by 2 or Higher layer scheduling~~	(S) (D) =(1,2) or (2,1)
4			2.13 – 2.39		(S) (D) =(1,3), (2,2) or (3,1)
5			2.80 – 3.06		(S) (D) = (1,4), (2,3), (3, 2) or (4,1)
7			4.13 – 4.39		(S) (D)=(1,6), (2,5), (3,4), (4,3), (5,2) or (6,1)
10			6.13 – 6.39		(D)=(3,7), (4,6), (5,5), (6,4) or (7,3)
14			8.80 – 9.06		(D) =(7,7)

(S): Single-frame method as shown in figure 14 (1).

(D): Double-frame method as shown in figure 14 (2). (x,y) indicates x: the number of idle slots in the first frame, y: the number of idle slots in the second frame.

NOTE: Compressed mode by spreading factor reduction is not supported when SF=4 is used in normal mode

3GPP TSG-RAN1 Meeting #41
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CR-Form-v7.1

CHANGE REQUEST

⌘	**25.212**	**CR**	**218**	⌘**rev**	**1**	⌘	Current version:	**6.4.0**	⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

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

Title:	⌘	Feature clean up: Removal of the 'compressed mode by puncturing'		
Source:	⌘	RAN WG1		
Work item code:	⌘	TEI6	***Date:*** ⌘	12/05/2005
Category:	⌘	**C**	***Release:*** ⌘	Rel-6
		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:* *Ph2 (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)* *Rel-7 (Release 7)*

Reason for change:	⌘	RAN #27 decided with RP-050144 to remove the feature 'CM by puncturing'.
Summary of change:	⌘	Text regarding the feature 'CM by puncturing' is removed.
Consequences if not approved:	⌘	Simplification of specifications and reduction of complexity would be missed. Further the RAN #27 decision would be violated.

Clauses affected:	⌘	4.2.5, 4.2.5.1, 4.2.5.3, 4.2.5.4, 4.2.7, 4.2.7.2, 4.2.7.2.1.2, 4.2.7.2.1.3, 4.2.9.1, 4.2.9.2, 4.2.10, 4.4.3, 4.4.3.1				
		Y	**N**			
Other specs affected:	⌘	X		Other core specifications	⌘	25.101, 25.133, 25.211, 25.214, 25.215, 25.331, 25.423, 25.433
				Test specifications		
			X	O&M Specifications		
Other comments:	⌘	Revision of R1-050479 with changes to 4.2.5.3, 4.2.5.4, 4.2.7				

How to create CRs using this form:

Comprehensive information and tips about how to create CRs can be found at http://www.3gpp.org/specs/CR.htm. Below is a brief summary:

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.

4.2.5 1st interleaving

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

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

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

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

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

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

$P1_{F_i}(x)$ defines the inter column permutation function for a TTI of length $F_i \times 10$ms, as defined in Table 4 in section 4.2.5.2. $P1_{F_i}(x)$ is the Bit Reversal function of x on $\log_2(F_i)$ bits.

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

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

col = 0

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

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

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

  col = col +1

end do

n = 0, m = 0

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

  col = *n* mod F_i

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

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

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

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

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

    m = m+1

~~endif~~

~~n = n +1~~

~~end do~~

4.2.5.2 1st interleaver operation

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

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

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

$$\mathrm{R1} = X_i / \mathrm{C1}.$$

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

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

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

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

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

(5) Read the output bit sequence $y_{i,1}, y_{i,2}, y_{i,3}, \ldots, y_{i,(\mathrm{C1}\times\mathrm{R1})}$ of the block interleaver column by column from the inter-column permuted R1 × C1 matrix. Bit $y_{i,1}$ corresponds to row 0 of column 0 and bit $y_{i,(\mathrm{R1}\times\mathrm{C1})}$ corresponds to row R1 - 1 of column C1 - 1.

Table 4 Inter-column permutation patterns for 1st interleaving

TTI	Number of columns C1	Inter-column permutation patterns <$\mathrm{P1}_{\mathrm{C1}}(0)$, $\mathrm{P1}_{\mathrm{C1}}(1)$, …, $\mathrm{P1}_{\mathrm{C1}}(\mathrm{C1}-1)$>
10 ms	1	<0>
20 ms	2	<0,1>
40 ms	4	<0,2,1,3>
80 ms	8	<0,4,2,6,1,5,3,7>

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

The bits input to the 1st interleaving are denoted by $t_{i,1}, t_{i,2}, t_{i,3}, \ldots, t_{i,T_i}$, where i is the TrCH number and T_i the number of bits. Hence, x~~z~~$_{i,k} = t_{i,k}$ and X~~Z~~$_i = T_i$.

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

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

If fixed positions of the TrCHs in a radio frame is used then the bits input to the 1st interleaving are denoted by $h_{i1}, h_{i2}, h_{i3}, \ldots, h_{iD_i}$, where i is the TrCH number. Hence, x~~z~~$_{ik} = h_{ik}$ and X~~Z~~$_i = D_i$.

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

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

4.2.6 Radio frame segmentation

When the transmission time interval is longer than 10 ms, the input bit sequence is segmented and mapped onto consecutive F_i radio frames. Following rate matching in the DL and radio frame size equalisation in the UL the input bit sequence length is guaranteed to be an integer multiple of F_i.

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 F_i 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:

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

where

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

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 to 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, $f_{i,k} = y_{i,n_i k}$ 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 TrCH multiplexing is identical to the total channel bit rate of the allocated dedicated physical channels.

If no bits are input to the rate matching for all TrCHs within a CCTrCH, the rate matching shall output no bits for all TrCHs within the CCTrCH and no uplink DPDCH will be selected in the case of uplink rate matching.

Notation used in subcla~~l~~use 4.2.7 and subclauses:

$N_{i,j}$: For uplink: Number of bits in a radio frame before rate matching on TrCH i with transport format combination j .

For downlink: An intermediate calculation variable (not an integer but a multiple of 1/8).

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

$\Delta N_{i,j}$: For uplink: If positive - number of bits that should be repeated in each radio frame on TrCH i with transport format combination j.

If negative - number of bits that should be punctured in each radio frame on TrCH i with transport format combination j.

For downlink : An intermediate calculation variable (not an integer but a multiple of 1/8).

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

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

Used in downlink only.

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

~~Used in downlink only.~~

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

~~Used in downlink only.~~

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

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

PL: Puncturing limit for uplink. This value limits the amount of puncturing that can be applied in order to avoid multicode or to enable the use of a higher spreading factor. Signalled from higher layers. The allowed puncturing in % is actually equal to (1-PL)*100.

$N_{data,j}$: Total number of bits that are available for the CCTrCH in a radio frame with transport format combination *j*.

I: Number of TrCHs in the CCTrCH.

$Z_{i,j}$: Intermediate calculation variable.

F_i: Number of radio frames in the transmission time interval of TrCH *i*.

F_{max} Maximum number of radio frames in a transmission time interval used in the CCTrCH :

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

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

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

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

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

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

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

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

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

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

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

b: Indicates systematic and parity bits

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

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

b=3: 2nd parity bit (from the lower Turbo constituent encoder). z'_k in subclause 4.2.3.2.1.

The * (star) notation is used to replace an index *x* when the indexed variable X_x does not depend on the index *x*. In the left wing of an assignment the meaning is that "$X_* = Y$" is equivalent to "**for all** *x* **do** $X_x = Y$ ". In the right wing of an assignment, the meaning is that "$Y = X_*$ " is equivalent to "**take any** *x* **and do** $Y = X_x$".

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

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

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

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

4.2.7.1 Determination of rate matching parameters in uplink

4.2.7.1.1 Determination of SF and number of PhCHs needed

In uplink, puncturing can be applied to match the CCTrCH bit rate to the PhCH bit rate. The bit rate of the PhCH(s) is limited by the UE capability and restrictions imposed by UTRAN, through limitations on the PhCH spreading factor. The maximum amount of puncturing that can be applied is 1-PL, PL is signalled from higher layers. The number of available bits in the radio frames of one PhCH for all possible spreading factors is given in [2]. Denote these values by N_{256}, N_{128}, N_{64}, N_{32}, N_{16}, N_8, and N_4, where the index refers to the spreading factor. The possible number of bits available to the CCTrCH on all PhCHs, N_{data}, then are { N_{256}, N_{128}, N_{64}, N_{32}, N_{16}, N_8, N_4, $2\times N_4$, $3\times N_4$, $4\times N_4$, $5\times N_4$, $6\times N_4$}.

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

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

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

If SET1 is not empty and the smallest element of SET1 requires just one PhCH then

$N_{data,j}$ = min SET1

else

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

Sort SET2 in ascending order

N_{data} = min SET2

While N_{data} is not the max of SET2 and the follower of N_{data} requires no additional PhCH do

N_{data} = follower of N_{data} in SET2

End while

$N_{data,j} = N_{data}$

End if

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

4.2.7.1.2 Determination of parameters needed for calculating the rate matching pattern

The number of bits to be repeated or punctured, $\Delta N_{i,j}$, within one radio frame for each TrCH *i* is calculated with equation 1 for all possible transport format combinations *j* and selected every radio frame. $N_{data,j}$ is given from subclause 4.2.7.1.1.

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

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

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

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

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

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

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

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

If $\Delta N_{i,j} \neq 0$ the parameters listed in subclauses 4.2.7.1.2.1 and 4.2.7.1.2.2 shall be used for determining e_{ini}, e_{plus}, and e_{minus} (regardless if the radio frame is compressed or not).

4.2.7.1.2.1 Convolutionally encoded TrCHs

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

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

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

else

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

endif

-- note: q is a signed quantity.

if q is even

then q' = q + gcd(|q|, F_i)/ F_i -- where gcd (|q|, F_i) means greatest common divisor of |q| and F_i

-- note that q' is not an integer, but a multiple of 1/8

else

q' = q

endif

for x = 0 to F_i - 1

S[| $\lfloor x \times q' \rfloor$ | mod F_i] = (| $\lfloor x \times q' \rfloor$ | div F_i)

end for

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

a = 2

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

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

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

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

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

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

4.2.7.1.2.2 Turbo encoded TrCHs

If repetition is to be performed on turbo encoded TrCHs, i.e. $\Delta N_{i,j} > 0$, the parameters in subclause 4.2.7.1.2.1 are used.

If puncturing is to be performed, the parameters below shall be used. Index b is used to indicate systematic (b=1), 1st parity (b=2), and 2nd parity bit (b=3).

$a=2$ when b=2

$a=1$ when b=3

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

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

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

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

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

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

X_i is as above:

$e_{ini} = (a \times S[P1_{Fi}(n_i)] \times |\Delta N_i| + X_i) \bmod (a \times X_i)$, if $e_{ini} = 0$ then $e_{ini} = a \times X_i$

$e_{plus} = a \times X_i$

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

4.2.7.2 Determination of rate matching parameters in downlink

For downlink channels other than the downlink shared channel(s) (DSCH), $N_{data,j}$ does not depend on the transport format combination j. $N_{data,*}$ is given by the channelization code(s) assigned by higher layers.

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

For a DSCH CCTrCH , different sets of channelisation codes may be configured by higher layers resulting in possibly multiple $N_{data,*}$ values, where $N_{data,*}$ is the number of bits available to the CCTrCH in one radio frame and is given by $N_{data,*}=P\times15\times(N_{data1}+N_{data2})$, where N_{data1} and N_{data2} are defined in [2]. Each $N_{data,*}$ corresponds to a sub-set of the Transport format combinations configured as part of the TFCS. For a DSCH CCTrCH only flexible positions apply. The rate matching calculations as specified in section 4.2.7.2.2 shall be performed for each $N_{data,*}$, where the TFCS taken into account in the calculations is restricted to the set of TFCs associated with $N_{data,*}$, as configured by higher layers. Therefore the amount of rate matching for a transport channel i for a TTI interval is a function of the $N_{data,*}$ value which shall be constant over the entire TTI as specified in section 4.2.14.

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

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

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

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

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

~~In case of compressed mode by puncturing and fixed positions, for some calculations, $N'_{data,*}$ is used for radio frames with gap instead of $N_{data,*}$, where $N'_{data,*} = P\times15\times(N'_{data1}+N'_{data2})$. N'_{data1} and N'_{data2} are the number of bits in the data fields of the slot format used for the frames compressed by puncturing.~~

4.2.7.2.1 Determination of rate matching parameters for fixed positions of TrCHs

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

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

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

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

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

If $\Delta N_{i,max} = 0$ then, for TrCH *i*, the output data of the rate matching is the same as the input data and the rate matching algorithm of subclause 4.2.7.5 does not need to be executed. In this case we have :

$$\forall l \in TFS(i)\ \Delta N_{i,l}^{TTI} = 0$$

If $\Delta N_{i,max} \neq 0$ the parameters listed in subclauses 4.2.7.2.1.3 and 4.2.7.2.1.4 shall be used for determining e_{ini}, e_{plus}, and e_{minus}, and $\Delta N_{i,l}^{TTI}$.

4.2.7.2.1.2 ~~Calculations for compressed mode by puncturing~~Void

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

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

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

~~Then an intermediate calculation variable $\Delta N_{i,*}$ is derived from $N_{i,*}$ by the formula given at subclause 4.2.7, for all TrCH *i*.~~

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$\Delta N^{TTI,cm,m}_{i,\max} = \Delta N^{m}_{i,\max} - Np^{TTI,m}_{i,\max}$$

If $\Delta N^{TTI,cm,m}_{i,\max} = 0$, then, for TrCH i, the output data of the rate matching is the same as the input data and the rate matching algorithm of subclause 4.2.7.5 does not need to be executed.

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

4.2.7.2.1.3 Determination of rate matching parameters for convolutionally encoded TrCHs

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

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

a=2

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

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

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

$$e_{ini} = 1$$

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

$$e_{\min us} = a \times |\Delta N_i|$$

Puncturing if $\Delta N_i < 0$, repetition otherwise. The values of $\Delta N_{i,l}^{TTI}$ may be computed by counting repetitions or puncturing when the algorithm of subclause 4.2.7.5 is run. The resulting values of $\Delta N_{i,l}^{TTI}$ can be represented with following expression.

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

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

4.2.7.2.1.4 Determination of rate matching parameters for Turbo encoded TrCHs

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

If puncturing is to be performed, the parameters below shall be used. Index *b* is used to indicate systematic (*b*=1), 1st parity (*b*=2), and 2nd parity bit (*b*=3).

$a=2$ when $b=2$

$a=1$ when $b=3$

The bits indicated by *b*=1 shall not be punctured.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.2.7.2.2 Determination of rate matching parameters for flexible positions of TrCHs

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

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

$$N_{i,j} = \frac{1}{F_i} \times N_{i,TF_i(j)}^{TTI}$$

Then rate matching ratios RF_i are calculated for each the transport channel *i* in order to minimise the number of DTX bits when the bit rate of the CCTrCH is maximum. The RF_i ratios are defined by the following formula:

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

The computation of $\Delta N_{i,l}^{TTI}$ parameters is then performed in two phases. In a first phase, tentative temporary values of $\Delta N_{i,l}^{TTI}$ are computed, and in the second phase they are checked and corrected. The first phase, by use of the RF_i ratios, ensures that the number of DTX indication bits inserted is minimum when the CCTrCH bit rate is maximum, but it does not ensure that the maximum CCTrCH bit rate is not greater than $N_{data,*}$. per 10ms. The latter condition is ensured through the checking and possible corrections carried out in the second phase.

At the end of the second phase, the latest value of $\Delta N_{i,l}^{TTI}$ is the definitive value.

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

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

The second phase is defined by the following algorithm:

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

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

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

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

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

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

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

end-if

end-for

end-if

end-for

If $\Delta N_{i,l}^{TTI} = 0$ then, for TrCH *i* at TF *l*, the output data of the rate matching is the same as the input data and the rate matching algorithm of subclause 4.2.7.5 does not need to be executed.

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

4.2.7.2.2.2 Determination of rate matching parameters for convolutionally encoded TrCHs

$\Delta N_i = \Delta N_{il}^{TTI}$

a=2

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

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

$e_{ini} = 1$

$e_{plus} = a \times N_{il}^{TTI}$

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

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

4.2.7.2.2.3 Determination of rate matching parameters for Turbo encoded TrCHs

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

If puncturing is to be performed, the parameters below shall be used. Index *b* is used to indicate systematic (*b*=1), 1st parity (*b*=2), and 2nd parity bit (*b*=3).

a=2 when *b*=2

a=1 when *b*=3

The bits indicated by *b*=1 shall not be punctured.

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

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

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

$$e_{ini} = X_i,$$

$$e_{plus} = a \times X_i$$

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

4.2.7.3 Bit separation and collection in uplink

The systematic bits of turbo encoded TrCHs shall not be punctured, the other bits may be punctured. The systematic bits, first parity bits, and second parity bits in the bit sequence input to the rate matching block are therefore separated into three sequences.

The first sequence contains:

- All of the systematic bits that are from turbo encoded TrCHs.
- From 0 to 2 first and/or second parity bits that are from turbo encoded TrCHs. These bits come into the first sequence when the total number of bits in a block after radio frame segmentation is not a multiple of three.
- Some of the systematic, first parity and second parity bits that are for trellis termination.

The second sequence contains:

- All of the first parity bits that are from turbo encoded TrCHs, except those that go into the first sequence when the total number of bits is not a multiple of three.
- Some of the systematic, first parity and second parity bits that are for trellis termination.

The third sequence contains:

- All of the second parity bits that are from turbo encoded TrCHs, except those that go into the first sequence when the total number of bits is not a multiple of three.
- Some of the systematic, first parity and second parity bits that are for trellis termination.

The second and third sequences shall be of equal length, whereas the first sequence can contain from 0 to 2 more bits. Puncturing is applied only to the second and third sequences.The bit separation function is transparent for convolutionally encoded TrCHs and for turbo encoded TrCHs with repetition. The bit separation and bit collection are illustrated in figures 5 and 6.

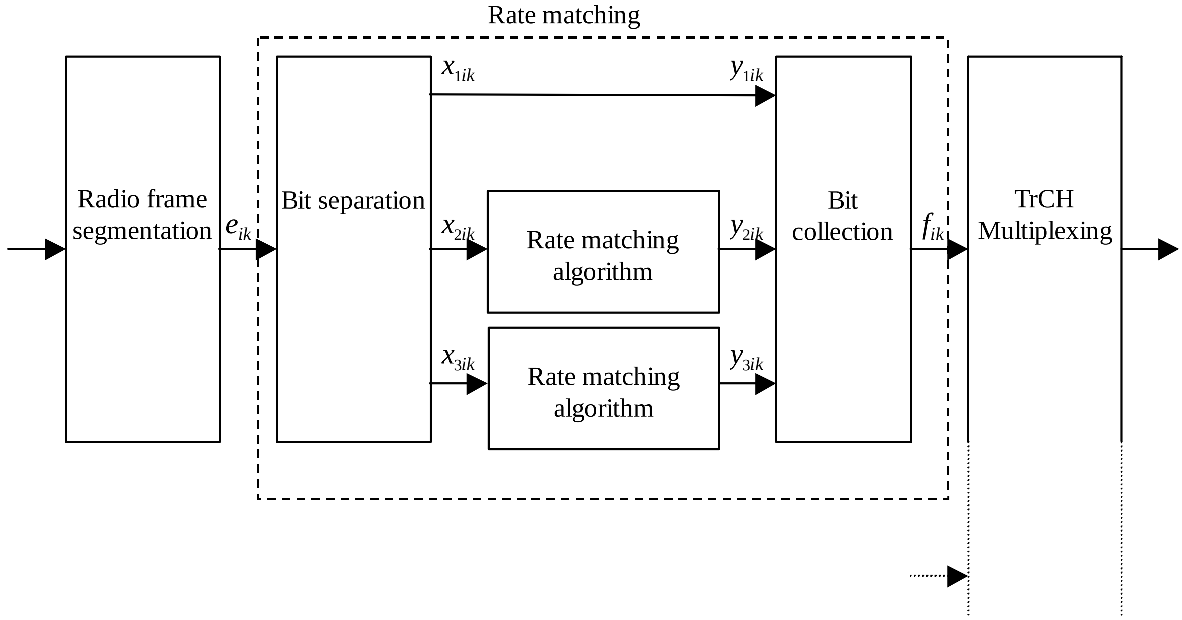


Figure 5: Puncturing of turbo encoded TrCHs in uplink

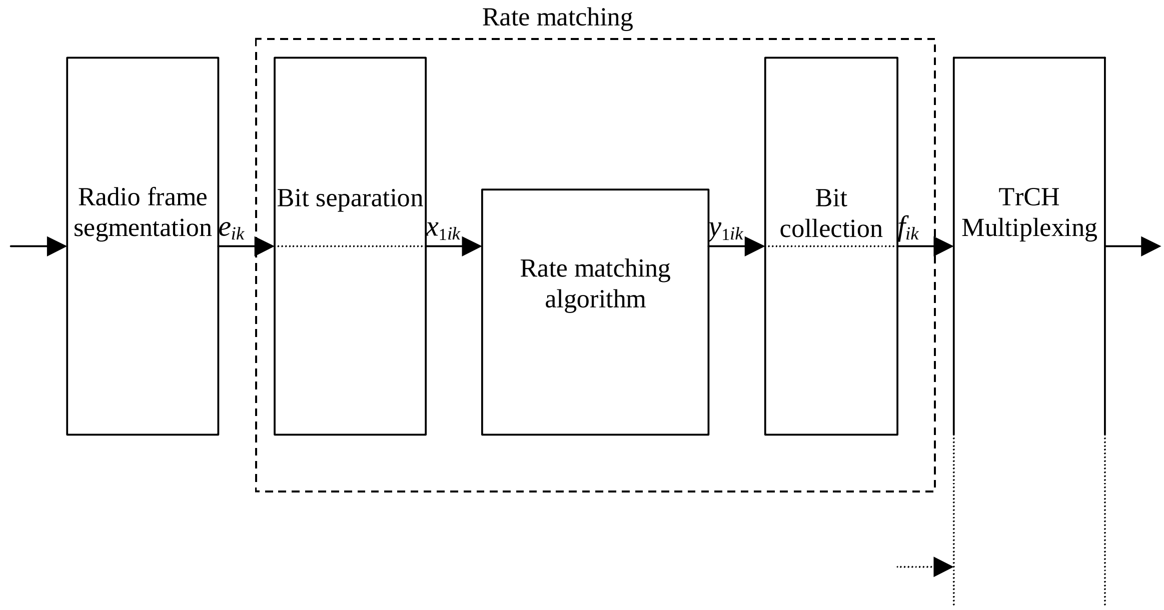


Figure 6: Rate matching for convolutionally encoded TrCHs and for turbo encoded TrCHs with repetition in uplink

The bit separation is dependent on the 1st interleaving and offsets are used to define the separation for different TTIs. b indicates the three sequences defined in this section, with b=1 indicating the first sequence, b = 2 the second one, and b = 3 the third one. The offsets α_b for these sequences are listed in table 5.

Table 5: TTI dependent offset needed for bit separation

TTI (ms)	α_1	α_2	α_3
10, 40	0	1	2
20, 80	0	2	1

The bit separation is different for different radio frames in the TTI. A second offset is therefore needed. The radio frame number for TrCH i is denoted by n_i. and the offset by β_{n_i}.

Table 6: Radio frame dependent offset needed for bit separation

TTI (ms)	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
10	0	NA	NA	NA	NA	NA	NA	NA
20	0	1	NA	NA	NA	NA	NA	NA
40	0	1	2	0	NA	NA	NA	NA
80	0	1	2	0	1	2	0	1

4.2.7.3.1 Bit separation

The bits input to the rate matching are 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 input to the rate matching block. Note that the transport format combination number *j* for simplicity has been left out in the bit numbering, i.e. $N_i=N_{ij}$. The bits after separation are denoted by $x_{bi1}, x_{bi2}, x_{bi3}, \ldots, x_{biX_i}$. For turbo encoded TrCHs with puncturing, *b* indicates the three sequences defined in section 4.2.7.3, with *b*=1 indicating the first sequence, and so forth. For all other cases *b* is defined to be 1. X_i is the number of bits in each separated bit sequence. The relation between e_{ik} and x_{bik} is given below.

For turbo encoded TrCHs with puncturing:

$x_{1,i,k} = e_{i,3(k-1)+1+(\alpha_1+\beta_{n_i}) \bmod 3}$ $k = 1, 2, 3, \ldots, X_i$ $X_i = \lfloor N_i/3 \rfloor$

$x_{1,i,\lfloor N_i/3 \rfloor+k} = e_{i,3\lfloor N_i/3 \rfloor+k}$ $k = 1, \ldots, N_i \bmod 3$ Note: When (N_i mod 3) = 0 this row is not needed.

$x_{2,i,k} = e_{i,3(k-1)+1+(\alpha_2+\beta_{n_i}) \bmod 3}$ $k = 1, 2, 3, \ldots, X_i$ $X_i = \lfloor N_i/3 \rfloor$

$x_{3,i,k} = e_{i,3(k-1)+1+(\alpha_3+\beta_{n_i}) \bmod 3}$ $k = 1, 2, 3, \ldots, X_i$ $X_i = \lfloor N_i/3 \rfloor$

For convolutionally encoded TrCHs and turbo encoded TrCHs with repetition:

$x_{1,i,k} = e_{i,k}$ $k = 1, 2, 3, \ldots, X_i$ $X_i = N_i$

4.2.7.3.2 Bit collection

The bits x_{bik} are input to the rate matching algorithm described in subclause 4.2.7.5. The bits output from the rate matching algorithm are denoted $y_{bi1}, y_{bi2}, y_{bi3}, \ldots, y_{biY_i}$.

Bit collection is the inverse function of the separation. The bits after collection are denoted by $z_{bi1}, z_{bi2}, z_{bi3}, \ldots, z_{biY_i}$. After bit collection, the bits indicated as punctured are removed and the bits are then denoted by $f_{i1}, f_{i2}, f_{i3}, \ldots, f_{iV_i}$, where *i* is the TrCH number and $V_i= N_{ij}+\Delta N_{ij}$. The relations between y_{bik}, z_{bik}, and f_{ik} are given below.

For turbo encoded TrCHs with puncturing ($Y_i=X_i$):

$z_{i,3(k-1)+1+(\alpha_1+\beta_{n_i}) \bmod 3} = y_{1,i,k}$ $k = 1, 2, 3, \ldots, Y_i$

$z_{i,3\lfloor N_i/3 \rfloor+k} = y_{1,i,\lfloor N_i/3 \rfloor+k}$ $k = 1, \ldots, N_i \bmod 3$ Note: When (N_i mod 3) = 0 this row is not needed.

$z_{i,3(k-1)+1+(\alpha_2+\beta_{n_i}) \bmod 3} = y_{2,i,k}$ $k = 1, 2, 3, \ldots, Y_i$

$z_{i,3(k-1)+1+(\alpha_3+\beta_{n_i}) \bmod 3} = y_{3,i,k}$ $k = 1, 2, 3, \ldots, Y_i$

After the bit collection, bits $z_{i,k}$ with value δ, where $\delta \notin \{0, 1\}$, are removed from the bit sequence. Bit $f_{i,1}$ corresponds to the bit $z_{i,k}$ with smallest index k after puncturing, bit $f_{i,2}$ corresponds to the bit $z_{i,k}$ with second smallest index k after puncturing, and so on.

For convolutionally encoded TrCHs and turbo encoded TrCHs with repetition:

$$z_{i,k} = y_{1,i,k} \qquad k = 1, 2, 3, \ldots, Y_i$$

When repetition is used, $f_{i,k}=z_{i,k}$ and $Y_i=V_i$.

When puncturing is used, $Y_i=X_i$ and bits $z_{i,k}$ with value δ, where $\delta \notin \{0, 1\}$, are removed from the bit sequence. Bit $f_{i,1}$ corresponds to the bit $z_{i,k}$ with smallest index k after puncturing, bit $f_{i,2}$ corresponds to the bit $z_{i,k}$ with second smallest index k after puncturing, and so on.

4.2.7.4 Bit separation and collection in downlink

The systematic bits of turbo encoded TrCHs shall not be punctured, the other bits may be punctured.

The systematic bits, first parity bits and second parity bits in the bit sequence input to the rate matching block are therefore separated into three sequences of equal lengths.

The first sequence contains :

- All of the systematic bits that are from turbo encoded TrCHs.
- Some of the systematic, first parity and second parity bits that are for trellis termination.

The second sequence contains:

- All of the first parity bits that are from turbo encoded TrCHs.
- Some of the systematic, first parity and second parity bits that are for trellis termination.

The third sequence contains:

- All of the second parity bits that are from turbo encoded TrCHs.
- Some of the systematic, first parity and second parity bits that are for trellis termination.

Puncturing is applied only to the second and third sequences.

The bit separation function is transparent for convolutionally encoded TrCHs and for turbo encoded TrCHs with repetition. The bit separation and bit collection are illustrated in figures 7 and 8.

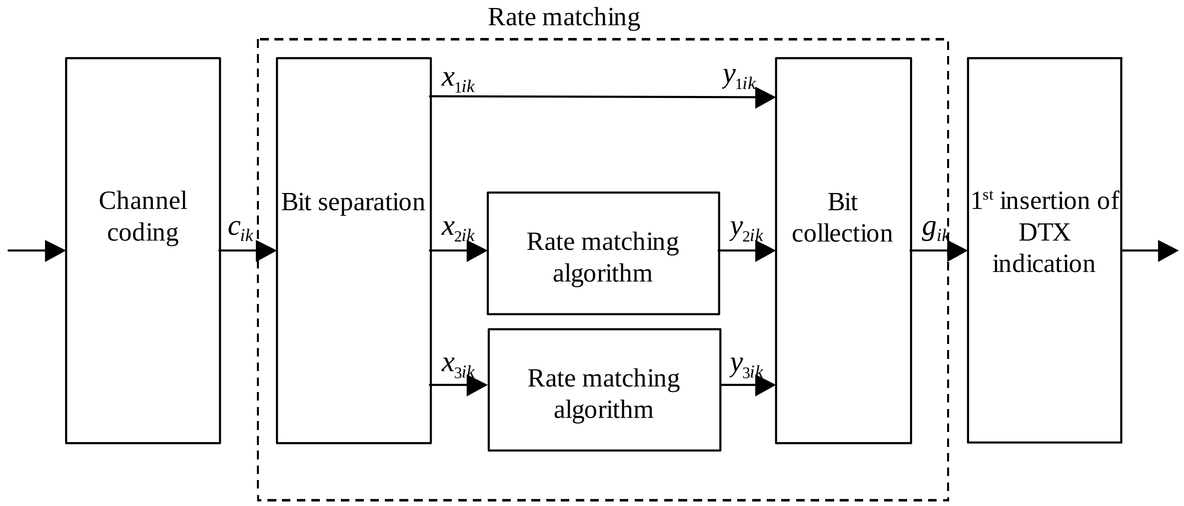


Figure 7: Puncturing of turbo encoded TrCHs in downlink

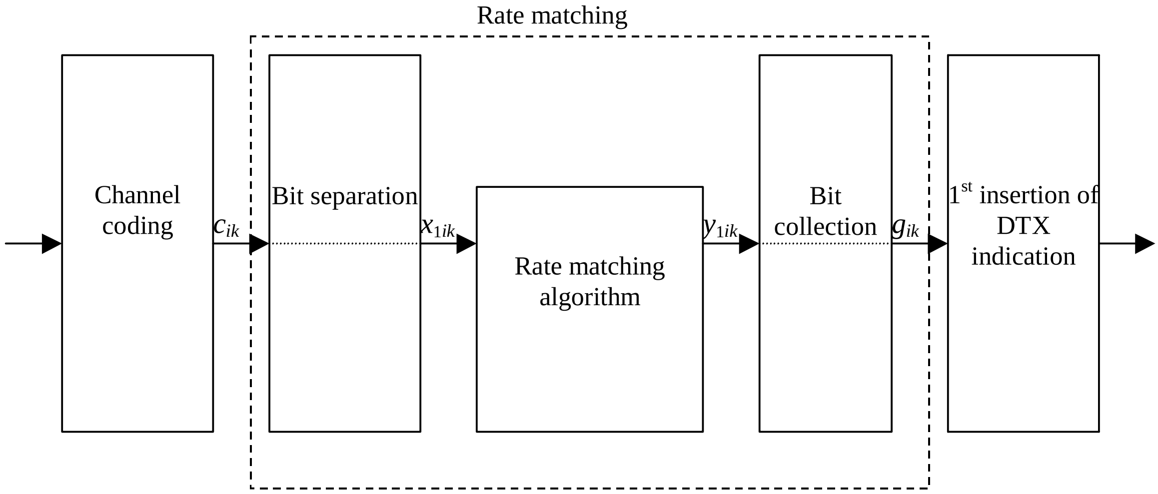


Figure 8: Rate matching for convolutionally encoded TrCHs and for turbo encoded TrCHs with repetition in downlink

4.2.7.4.1 Bit separation

The bits input to the rate matching are denoted by $c_{i1}, c_{i2}, c_{i3}, \ldots, c_{iE_i}$, where i is the TrCH number and E_i is the number of bits input to the rate matching block. Note that E_i is a multiple of 3 for turbo encoded TrCHs and that the transport format l for simplicity has been left out in the bit numbering, i.e. $E_i = N_{il}^{TTI}$. The bits after separation are denoted by $x_{bi1}, x_{bi2}, x_{bi3}, \ldots, x_{biX_i}$. For turbo encoded TrCHs with puncturing, b indicates the three sequences defined in section 4.2.7.4, with b=1 indicating the first sequence, and so forth. For all other cases b is defined to be 1. X_i is the number of bits in each separated bit sequence. The relation between c_{ik} and x_{bik} is given below.

For turbo encoded TrCHs with puncturing:

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

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

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

For convolutionally encoded TrCHs and turbo encoded TrCHs with repetition:

$x_{1,i,k} = c_{i,k}$ $k = 1, 2, 3, \ldots, X_i$ $X_i = E_i$

4.2.7.4.2 Bit collection

The bits x_{bik} are input to the rate matching algorithm described in subclause 4.2.7.5. The bits output from the rate matching algorithm are denoted $y_{bi1}, y_{bi2}, y_{bi3}, \ldots, y_{biY_i}$.

Bit collection is the inverse function of the separation. The bits after collection are denoted by $z_{bi1}, z_{bi2}, z_{bi3}, \ldots, z_{biY_i}$. After bit collection, the bits indicated as punctured are removed and the bits are then denoted by $g_{i1}, g_{i2}, g_{i3}, \ldots, g_{iG_i}$, where i is the TrCH number and $G_i = N_{il}^{TTI} + \Delta N_{il}^{TTI}$. The relations between y_{bik}, z_{bik}, and g_{ik} are given below.

For turbo encoded TrCHs with puncturing ($Y_i = X_i$):

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

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

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

After the bit collection, bits $z_{i,k}$ with value δ, where $\delta \notin \{0, 1\}$, are removed from the bit sequence. Bit $g_{i,1}$ corresponds to the bit $z_{i,k}$ with smallest index k after puncturing, bit $g_{i,2}$ corresponds to the bit $z_{i,k}$ with second smallest index k after puncturing, and so on.

For convolutionally encoded TrCHs and turbo encoded TrCHs with repetition:

$z_{i,k} = y_{1,i,k}$ $k = 1, 2, 3, \ldots, Y_i$

When repetition is used, $g_{i,k}=z_{i,k}$ and $Y_i=G_i$.

When puncturing is used, $Y_i=X_i$ and bits $z_{i,k}$ with value δ, where $\delta \notin \{0, 1\}$, are removed from the bit sequence. Bit $g_{i,1}$ corresponds to the bit $z_{i,k}$ with smallest index k after puncturing, bit $g_{i,2}$ corresponds to the bit $z_{i,k}$ with second smallest index k after puncturing, and so on.

4.2.7.5 Rate matching pattern determination

Denote the bits before rate matching by:

$x_{i1}, x_{i2}, x_{i3}, \ldots, x_{iX_i}$, where i is the TrCH number and the sequence is defined in 4.2.7.3 for uplink or in 4.2.7.4 for downlink. Parameters X_i, e_{ini}, e_{plus}, and e_{minus} are given in 4.2.7.1 for uplink or in 4.2.7.2 for downlink.

The rate matching rule is as follows:

```
if puncturing is to be performed
    e = e_ini          -- initial error between current and desired puncturing ratio
    m = 1              -- index of current bit
    do while m <= X_i
        e = e – e_minus        -- update error
        if e <= 0 then         -- check if bit number m should be punctured
            set bit x_i,m to δ where δ∉{0, 1}
            e = e + e_plus     -- update error
        end if
        m = m + 1              --   next bit
    end do
else
    e = e_ini          -- initial error between current and desired puncturing ratio
    m = 1              -- index of current bit
    do while m <= X_i
        e = e – e_minus        -- update error
        do while e <= 0        -- check if bit number m should be repeated
            repeat bit x_i,m
            e = e +   e_plus -- update error
```

end do

m = m + 1 -- *next bit*

end do

end if

A repeated bit is placed directly after the original one.

4.2.8 TrCH multiplexing

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).

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:

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

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

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

$\ldots$

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

4.2.9 Insertion of discontinuous transmission (DTX) indication bits

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

4.2.9.1 1st insertion of DTX indication bits

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

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

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

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

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

$h_{ik} = g_{ik}$ k = 1, 2, 3, …, G_i

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

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

4.2.9.2 2nd insertion of DTX indication bits

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

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

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

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

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

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

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

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

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

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

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

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

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

$w_k = s_k$ k = 1, 2, 3, …, S

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

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

4.2.10 Physical channel segmentation

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

The bits after physical channel segmentation are denoted $u_{p,1}, u_{p,2}, u_{p,3}, \ldots, u_{p,U}$, where p is PhCH number and U is the number of bits in one radio frame for each PhCH, i.e. ~~$U = (X - N_{TGL} - (N_{data,*} - N'_{data,*}))/P$ for compressed mode by puncturing, and~~ $U = \frac{X}{P}$ ~~otherwise~~. The relation between x_k and $u_{p,k}$ is given below.

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

Bits on first PhCH after physical channel segmentation:

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

Bits on second PhCH after physical channel segmentation:

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

…

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

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

~~where f is such that :~~

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

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

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

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

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

4.2.11 2nd interleaving

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

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

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

$U \le \mathrm{R2} \times \mathrm{C2}$.

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

(3) Write the input bit sequence $u_{p,1}, u_{p,2}, u_{p,3}, \ldots, u_{p,U}$ into the R2 × C2 matrix row by row starting with bit $y_{p,1}$ in column 0 of row 0:

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

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

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

$$\begin{bmatrix} y'_{p,1} & y'_{p,(\mathrm{R2}+1)} & y'_{p,(2\times\mathrm{R2}+1)} & \ldots & y'_{p,((\mathrm{C2}-1)\times\mathrm{R2}+1)} \\ y'_{p,2} & y'_{p,(\mathrm{R2}+2)} & y'_{p,(2\times\mathrm{R2}+2)} & \ldots & y'_{p,((\mathrm{C2}-1)\times\mathrm{R2}+2)} \\ \vdots & \vdots & \vdots & \ldots & \vdots \\ y'_{p,\mathrm{R2}} & y'_{p,(2\times\mathrm{R2})} & y'_{p,(3\times\mathrm{R2})} & \ldots & y'_{p,(\mathrm{C2}\times\mathrm{R2})} \end{bmatrix}$$

(5) The output of the block interleaver is the bit sequence read out column by column from the inter-column permuted R2 × C2 matrix. The output is pruned by deleting dummy bits that were padded to the input of the matrix before the inter-column permutation, i.e. bits $y'_{p,k}$ that corresponds to bits $y_{p,k}$ with *k*>*U* are removed from the output. The bits after 2nd interleaving are denoted by $v_{p,1}, v_{p,2}, \ldots, v_{p,U}$, where $v_{p,1}$ corresponds to the bit $y'_{p,k}$ with smallest index *k* after pruning, $v_{p,2}$ to the bit $y'_{p,k}$ with second smallest index *k* after pruning, and so on.

Table 7 Inter-column permutation pattern for 2nd interleaving

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

4.2.12 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 $v_{p,1}, v_{p,2}, \ldots, v_{p,U}$, where *p* is the PhCH number and *U* is the number of bits in one radio frame for one PhCH. The bits $v_{p,k}$ are mapped to the PhCHs so that the bits for each PhCH are transmitted over the air in ascending order with respect to k.

In compressed mode, no bits are mapped to certain slots of the PhCH(s). If $N_{first} + TGL \leq 15$, no bits are mapped to slots N_{first} to N_{last}. If $N_{first} + TGL > 15$, i.e. the transmission gap spans two consecutive radio frames, the mapping is as follows:

- In the first radio frame, no bits are mapped to slots N_{first}, $N_{first}+1$, $N_{first}+2$, …, 14.
- In the second radio frame, no bits are mapped to the slots 0, 1, 2, …, N_{last}.

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

4.2.12.1 Uplink

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. The only exception is when the UE is in compressed mode. The transmission can then be turned off during consecutive slots of the radio frame.

4.2.12.2 Downlink

In downlink, the PhCHs do not need to be completely filled with bits that are transmitted over the air. Values $v_{p,k} \notin \{0, 1\}$ correspond to DTX indicators, which are mapped to the DPCCH/DPDCH fields but are not transmitted over the air.

During compressed mode by reducing the spreading factor by 2, the data bits are always mapped into 7.5 slots within a compressed frame. No bits are mapped to the DPDCH field as follows:

If $N_{first} + TGL \leq 15$, i.e. the transmission gap spans one radio frame,

if $N_{first} + 7 \leq 14$

no bits are mapped to slots N_{first},$N_{first} + 1$, $N_{first} +2$,…, $N_{first}+6$

no bits are mapped to the first $(N_{Data1}+ N_{Data2})/2$ bit positions of slot $N_{first}+7$

else

no bits are mapped to slots N_{first}, $N_{first} + 1$, $N_{first} + 2$,…, 14

no bits are mapped to slots $N_{first} - 1$, $N_{first} - 2$, $N_{first} - 3$, …, 8

no bits are mapped to the last $(N_{Data1}+ N_{Data2})/2$ bit positions of slot 7

end if

If $N_{first} + TGL > 15$, i.e. the transmission gap spans two consecutive radio frames,

In the first radio frame, no bits are mapped to last $(N_{Data1}+ N_{Data2})/2$ bit positions in slot 7 as well as to slots 8, 9, 10, ..., 14.

In the second radio frame, no bits are mapped to slots 0, 1, 2, ..., 6 as well as to first $(N_{Data1}+ N_{Data2})/2$ bit positions in slot 7.

$N_{Data1}$and N_{Data2} are defined in [2].

4.2.13 Restrictions on different types of CCTrCHs

Restrictions on the different types of CCTrCHs are described in general terms in TS 25.302[11]. In this subclause those restrictions are given with layer 1 notation.

4.2.13.1 Uplink Dedicated channel (DCH)

The maximum value of the number of TrCHs I in a CCTrCH, the maximum value of the number of transport blocks M_i on each transport channel, and the maximum value of the number of DPDCHs P are given from the UE capability class.

4.2.13.2 Random Access Channel (RACH)

- There can only be one TrCH in each RACH CCTrCH, i.e. I=1, $s_k = f_{1k}$ and $S = V_1$.
- The maximum value of the number of transport blocks M_1 on the transport channel is given from the UE capability class.
- The transmission time interval is either 10 ms or 20 ms.
- Only one PRACH is used, i.e. P=1, $u_{1k} = s_k$, and $U = S$.
- The Static rate matching parameter RM_1 is not provided by higher layer signalling on the System information as the other transport channel parameters. Any value may be used as there is one transport channel in the CCTrCH, hence one transport channel per Transport Format Combination and no need to do any balancing between multiple transport channels.

4.2.13.3 Common Packet Channel (CPCH)

- There can only be one TrCH in each CPCH CCTrCH, i.e. I=1, $s_k = f_{1k}$ and $S = V_1$.
- The maximum value of the number of transport blocks M_1 on the transport channel is given from the UE capability class.
- Only one PCPCH is used, i.e. P=1, $u_{1k} = s_k$, and $U = S$.

4.2.13.4 Downlink Dedicated Channel (DCH)

The maximum value of the number of TrCHs I in a CCTrCH, the maximum value of the number of transport blocks M_i on each transport channel, and the maximum value of the number of DPDCHs P are given from the UE capability class.

4.2.13.5 Downlink Shared Channel (DSCH) associated with a DCH

- The spreading factor is indicated with the TFCI of the associated DPCH.
- The maximum value of the number of TrCHs I in a CCTrCH, the maximum value of the number of transport blocks M_I on the transport channel and the maximum value of the number of PDSCHs P are given from the UE capability class.

4.2.13.6 Broadcast channel (BCH)

- There can only be one TrCH in the BCH CCTrCH, i.e. I=1, $s_k = f_{1k}$, and $S = V_1$.
- There can only be one transport block in each transmission time interval, i.e. M_1 = 1.
- All transport format attributes have predefined values which are provided in [11] apart from the rate matching RM_1.
- The Static rate matching parameter RM_1 is not provided by higher layer signalling neither fixed. Any value may be used as there is one transport channel in the CCTrCH, hence one transport channel per Transport Format Combination and no need to do any balancing between multiple transport channels.
- Only one primary CCPCH is used, i.e. P=1.

4.2.13.7 Forward access and paging channels (FACH and PCH)

- The maximum value of the number of TrCHs I in a CCTrCH and the maximum value of the number of transport blocks M_i on each transport channel are given from the UE capability class.
- The transmission time interval for TrCHs of PCH type is always 10 ms.
- Only one secondary CCPCH is used per CCTrCH, i.e. P=1.

4.2.13.8 High Speed Downlink Shared Channel (HS-DSCH) associated with a DCH

- There can be only one TrCH in the HS-DSCH CCTrCH, i.e. $I = 1$,
- There can only be one transport block in each transmission time interval, i.e. $M_1 = 1$.
- The transmission time interval for TrCHs of HS-DSCH type is always 2 ms.
- The maximum value of the number of HS-PDSCHs P are given from the UE capability class.

4.2.13.9 Enhanced Dedicated Channel (E-DCH)

- There can be only one TrCH in the E-DCH CCTrCH, i.e. $I = 1$.
- There can only be one transport block in each transmission time interval, i.e. $M_1 = 1$.
- The transmission time interval for TrCHs of E-DCH type is 2 ms or 10 ms.
- The maximum value of the number of E-DPDCHs P are given from the UE capabilities.

4.2.14 Multiplexing of different transport channels into one CCTrCH, and mapping of one CCTrCH onto physical channels

The following rules shall apply to the different transport channels which are part of the same CCTrCH:

1) Transport channels multiplexed into one CCTrCh shall have co-ordinated timings. When the TFCS of a CCTrCH is changed because one or more transport channels are added to the CCTrCH or reconfigured within the CCTrCH, or removed from the CCTrCH, the change may only be made at the start of a radio frame with CFN fulfilling the relation

   CFN mod F_{max} = 0,

   where F_{max} denotes the maximum number of radio frames within the transmission time intervals of all transport channels which are multiplexed into the same CCTrCH, including any transport channels i which are added, reconfigured or have been removed, and CFN denotes the connection frame number of the first radio frame of the changed CCTrCH.

   After addition or reconfiguration of a transport channel i within a CCTrCH, the TTI of transport channel i may only start in radio frames with CFN fulfilling the relation:

   CFN mod F_i = 0.

   For a CCTrCH of DSCH type, a modification of number of bits $N_{data,*}$ allocated on a radio frame is allowed if the CFN verifies CFN mod F_{max} = 0, where F_{max} denotes the maximum number of radio frames within the transmission time intervals of all the transport channels with a non zero transport block transport format multiplexed into the CCTrCH in the previous radio frame.

2) Only transport channels with the same active set can be mapped onto the same CCTrCH.
3) Different CCTrCHs cannot be mapped onto the same PhCH.
4) One CCTrCH shall be mapped onto one or several PhCHs. These physical channels shall all have the same SF.
5) Dedicated Transport channels and common transport channels cannot be multiplexed into the same CCTrCH.
6) For the common transport channels, only the FACH and PCH may belong to the same CCTrCH.

There are hence two types of CCTrCH:

1) CCTrCH of dedicated type, corresponding to the result of coding and multiplexing of one or several DCHs or one E-DCH.
2) CCTrCH of common type, corresponding to the result of the coding and multiplexing of a common channel, RACH in the uplink, DSCH, HS-DSCH, BCH, or FACH/PCH for the downlink.

4.2.14.1 Allowed CCTrCH combinations for one UE

4.2.14.1.1 Allowed CCTrCH combinations on the uplink

The following CCTrCH combinations for one UE are allowed:

1) one CCTrCH of dedicated type or

1a) two CCTrCHs of dedicated type, one being of DCH type and the other one of E-DCH type or

2) one CCTrCH of common type.

4.2.14.1.2 Allowed CCTrCH combinations on the downlink

The following CCTrCH combinations for one UE are allowed:

- x CCTrCH of dedicated type + y CCTrCH of common type. The allowed combination of CCTrCHs of dedicated and common type are given from UE radio access capabilities. There can be a maximum of one CCTrCH of common type for DSCH. The maximum number of CCTrCHs of common type for FACH is determined from UE capabilities. With one CCTrCH of common type for DSCH, there shall be only one CCTrCH of dedicated type.

NOTE 1: There is only one DPCCH in the uplink, hence one TPC bits flow on the uplink to control possibly the different DPDCHs on the downlink, part of the same or several CCTrCHs.

NOTE 2: There is only one DPCCH in the downlink, even with multiple CCTrCHs. With multiple CCTrCHs, the DPCCH is transmitted on one of the physical channels of that CCTrCH which has the smallest SF among the multiple CCTrCHs. Thus there is only one TPC command flow and only one TFCI word in downlink even with multiple CCTrCHs.

NOTE 3: in the current release, only 1 CCTrCH of dedicated type is supported.

4.3 Transport format detection

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

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

If the transport format set for a TrCH *i* does not contain more than one transport format with more than zero transport blocks, no explicit blind transport format detection needs to be performed for this TrCH. The UE can use guided detection for this TrCH or single transport format detection, where the UE always assumes the transport format corresponding to more than zero transport blocks for decoding.

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

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

4.3.1 Blind transport format detection

When no TFCI is available then explicit blind detection or guided detection shall be performed on all TrCHs within the CCTrCH that have more than one transport format and that do not use single transport format detection. The UE shall only be required to support blind transport format detection if all of the following restrictions are fulfilled:

1. either only one CCTrCH is received, or one CCTrCH of dedicated type and one CCTrCH of common type for HS-DSCH are received by the UE;

If only one CCTrCH is received by the UE, the following conditions apply to that CCTrCH and those TrCHs that are multiplexed on the CCTrCH. If one CCTrCH of dedicated type and one CCTrCH of common type for HS-DSCH are received by the UE, the following conditions apply to the dedicated type CCTrCH and the TrCHs that are multiplexed on the dedicated type CCTrCH.

2. the number of CCTrCH bits received per radio frame is 600 or less;
3. the number of transport format combinations of the CCTrCH is 64 or less;
4. fixed positions of the transport channels is used on the CCTrCH to be detectable;
5. convolutional coding is used on all explicitly detectable TrCHs;
6. CRC with non-zero length is appended to all transport blocks on all explicitly detectable TrCHs;
7. at least one transport block shall be transmitted per TTI on each explicitly detectable TrCH;
8. the number of explicitly detectable TrCHs is 3 or less;
9. for all explicitly detectable TrCHs *i*, the number of code blocks in one TTI (C_i) shall not exceed 1;
10. the sum of the transport format set sizes of all explicitly detectable TrCHs, is 16 or less. The transport format set size is defined as the number of transport formats within the transport format set;
11. there is at least one TrCH that can be used as the guiding transport channel for all transport channels using guided detection.

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

4.3.1a Single transport format detection

When no TFCI is available, then single transport format detection shall be applied on all TrCHs within the CCTrCH that have a transport format set not containing more than one transport format with more than zero transport blocks and that do not use guided detection. The UE shall only be required to support single transport format detection if the following restrictions are fulfilled:

1. For each transport channel that is single transport format detected, CRC with non-zero length is appended to all transport blocks within the non-zero transport block transport format;
2. fixed positions of the transport channels is used on the CCTrCH to be detectable.

4.3.2 Transport format detection based on TFCI

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

If higher layers indicate that S-CCPCHs can be soft combined, then the same TFC is used on those S-CCPCHs during the radio frames when soft combining is possible. The UE may therefore detect TFCI on one S-CCPCH to determine the TFC on all S-CCPCHs that can be soft combined. (S-CCPCH soft combining is further specified in [4]).

4.3.3 Coding of Transport-Format-Combination Indicator (TFCI)

The TFCI is encoded using a (32, 10) sub-code of the second order Reed-Muller code. The coding procedure is as shown in figure 9.

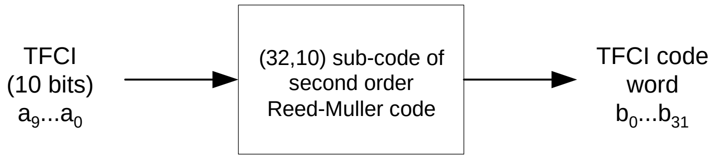


Figure 9: Channel coding of TFCI information bits

If the TFCI consist of less than 10 bits, it is padded with zeros to 10 bits, by setting the most significant bits to zero. The length of the TFCI code word is 32 bits.

The code words of the (32,10) sub-code of second order Reed-Muller code are linear combination of 10 basis sequences. The basis sequences are as in the following table 8.

Table 8: Basis sequences for (32,10) TFCI code

i	$M_{i,0}$	$M_{i,1}$	$M_{i,2}$	$M_{i,3}$	$M_{i,4}$	$M_{i,5}$	$M_{i,6}$	$M_{i,7}$	$M_{i,8}$	$M_{i,9}$
0	1	0	0	0	0	1	0	0	0	0
1	0	1	0	0	0	1	1	0	0	0
2	1	1	0	0	0	1	0	0	0	1
3	0	0	1	0	0	1	1	0	1	1
4	1	0	1	0	0	1	0	0	0	1
5	0	1	1	0	0	1	0	0	1	0
6	1	1	1	0	0	1	0	1	0	0
7	0	0	0	1	0	1	0	1	1	0
8	1	0	0	1	0	1	1	1	1	0
9	0	1	0	1	0	1	1	0	1	1
10	1	1	0	1	0	1	0	0	1	1
11	0	0	1	1	0	1	0	1	1	0
12	1	0	1	1	0	1	0	1	0	1
13	0	1	1	1	0	1	1	0	0	1
14	1	1	1	1	0	1	1	1	1	1
15	1	0	0	0	1	1	1	1	0	0
16	0	1	0	0	1	1	1	1	0	1
17	1	1	0	0	1	1	1	0	1	0
18	0	0	1	0	1	1	0	1	1	1
19	1	0	1	0	1	1	0	1	0	1
20	0	1	1	0	1	1	0	0	1	1
21	1	1	1	0	1	1	0	1	1	1
22	0	0	0	1	1	1	0	1	0	0
23	1	0	0	1	1	1	1	1	0	1
24	0	1	0	1	1	1	1	0	1	0
25	1	1	0	1	1	1	1	0	0	1
26	0	0	1	1	1	1	0	0	1	0
27	1	0	1	1	1	1	1	1	0	0
28	0	1	1	1	1	1	1	1	1	0
29	1	1	1	1	1	1	1	1	1	1
30	0	0	0	0	0	1	0	0	0	0
31	0	0	0	0	1	1	1	0	0	0

The TFCI information bits a_0 , a_1 , a_2 , a_3 , a_4 , a_5 , a_6 , a_7 , a_8 , a_9 (where a_0 is LSB and a_9 is MSB) shall correspond to the TFC index (expressed in unsigned binary form) defined by the RRC layer to reference the TFC of the CCTrCH in the associated DPCH radio frame.

The output code word bits b_i are given by:

$$b_i = \sum_{n=0}^{9} (a_n \times M_{i,n}) \bmod 2$$

where $i = 0, \ldots, 31$.

The output bits are denoted by b_k, $k = 0, 1, 2, \ldots, 31$.

In downlink, when the SF < 128 the encoded TFCI code words are repeated yielding 8 encoded TFCI bits per slot in normal mode and 16 encoded TFCI bits per slot in compressed mode. Mapping of repeated bits to slots is explained in subclause 4.3.5.

4.3.4 Operation of TFCI in Hard Split Mode

If one of the DCH is associated with a DSCH, the TFCI code word may be split in such a way that the code word relevant for TFCI activity indication is not transmitted from every cell. The use of such a functionality shall be indicated by higher layer signalling.

The TFCI is encoded by using punctured code of (32,10) sub-code of second order Reed-Muller code. The coding procedure is as shown in figure 10.

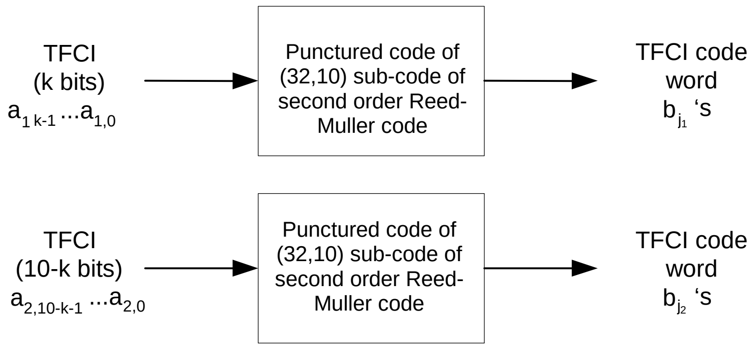


Figure 10: Channel coding of flexible hard split mode TFCI information bits

The code words of the punctured code of (32,10) sub-code of second order Reed-Muller code are linear combinations of basis sequences generated by puncturing 10 basis sequences defined in table 8 in section 4.3.3.

The first set of TFCI information bits ($a_{1,0}$, $a_{1,1}$, $a_{1,2}$, $a_{1,3}$, …, $a_{1,k-1}$ where $a_{1,0}$ is LSB and $a_{1,k-1}$ is MSB) shall correspond to the TFC index (expressed in unsigned binary form) defined by the RRC layer to reference the TFC of the DCH CCTrCH in the associated DPCH radio frame.

The second set of TFCI information bits ($a_{2,0}$, $a_{2,1}$, $a_{2,2}$, $a_{2,3}$, .., $a_{2,10-k-1}$ where $a_{2,0}$ is LSB and $a_{2,10-k-1}$ is MSB) shall correspond to the TFC index (expressed in unsigned binary form) defined by the RRC layer to reference the TFC of the associated DSCH CCTrCH in the corresponding PDSCH radio frame.

The output code word bits are given by :

$$b_{j_1} = \sum_{n=0}^{k-1} (a_{1,n} \times M_{\pi_1(k,i_1),\pi_2(k,n)}) \bmod 2 \, ; \qquad b_{j_2} = \sum_{n=0}^{10-k-1} (a_{2,n} \times M_{\pi_1(10-k,i_2),\pi_2(10-k,n)}) \bmod 2$$

where $i_1 = 0, \ldots, 3\times k$ and $i_2 = 0, \ldots, 30-3\times k$.

Then, the relation between j_1 (or j_2) and i_1 (or i_2) is as follows:

$$j_1 = \left\lfloor \frac{32}{3\times k+1} \times \left(i_1 + 1 - \frac{1}{2}\left\lfloor \frac{k}{5} \right\rfloor\right) + \frac{1}{2} \right\rfloor - 1 \, ; \qquad j_2 = \left\lfloor \frac{32}{32-(3\times k+1)} \times \left(i_2 + \frac{1}{2}\left(1 + \left\lfloor \frac{k}{5} \right\rfloor\right)\right) + \frac{1}{2} \right\rfloor - 1 .$$

The functions π_1, π_2 are defined as shown in the following table 9.

Table 9. π_1, π_2 functions

m	$\pi_1(m,i)$ for i = 0, …, 3×m	$\pi_2(m,n)$ for n = 0,…, m-1
3	0, 1, 2, 3, 4, 5, 6, 8, 9, 11	0, 1, 2
4	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	0, 1, 2, 3
5	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 30	0, 1, 2, 3, 5
6	0, 1, 2, 3, 4, 5, 7, 8, 9, 12, 15, 18, 21, 23, 25, 27, 28, 29, 30	0, 1, 2, 3, 4, 5
7	0, 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 13, 14, 15, 17, 20, 21, 22, 24, 25, 28, 29	0, 1, 2, 3, 4, 6, 7

4.3.5 Mapping of TFCI words

4.3.5.1 Mapping of TFCI word in normal mode

The bits of the code word are directly mapped to the slots of the radio frame. Within a slot the bit with lower index is transmitted before the bit with higher index. The coded bits b_k, are mapped to the transmitted TFCI bits d_k, according to the following formula:

$$d_k = b_{k \bmod 32}$$

For uplink physical channels regardless of the SF and downlink physical channels, if SF≥128, $k = 0, 1, 2, \ldots, 29$. Note that this means that bits b_{30} and b_{31} are not transmitted.

For downlink physical channels whose SF < 128, $k = 0, 1, 2, \ldots, 119$. Note that this means that bits b_0 to b_{23} are transmitted four times and bits b_{24} to b_{31} are transmitted three times.

4.3.5.2 Mapping of TFCI word in compressed mode

The mapping of the TFCI bits in compressed mode is different for uplink, downlink with SF ≥ 128 and downlink with SF < 128.

4.3.5.2.1 Uplink compressed mode

For uplink compressed mode, the slot format is changed so that no TFCI coded bits are lost. The different slot formats in compressed mode do not match the exact number of TFCI coded bits for all possible TGLs. Repetition of the TFCI bits is therefore used.

Denote the number of bits available in the TFCI fields of one compressed radio frame by D and the number of bits in the TFCI field in a slot by N_{TFCI}. The parameter E is used to determine the number of the first TFCI bit to be repeated.

$E = N_{first} N_{TFCI}$, if the start of the transmission gap is allocated to the current frame.
$E = 0$, if the start of the transmission gap is allocated to the previous frame and the end of the transmission gap is allocated to the current frame.

The TFCI coded bits b_k are mapped to the bits in the TFCI fields d_k. The following relations define the mapping for each compressed frame.

$$d_k = b_k$$

where $k = 0, 1, 2, \ldots, \min(31, D-1)$.

If $D > 32$, the remaining positions are filled by repetition (in reversed order):

$$d_{D-k-1} = b_{(E+k) \bmod 32}$$

where $k = 0, \ldots, D-33$.

4.3.5.2.2 Downlink compressed mode

For downlink compressed mode, the slot format is changed so that no TFCI coded bits are lost. The different slot formats in compressed mode do not match the exact number of TFCI bits for all possible TGLs. DTX is therefore used if the number of bits available in the TFCI fields in one compressed frame exceeds the number of TFCI bits given from the slot format. The block of bits in the TFCI fields where DTX is used starts on the first TFCI field after the transmission gap. If there are more bits available in the TFCI fields before the transmission gap than TFCI bits, DTX is also used on the bits in the last TFCI fields before the transmission gap.

Denote the number of bits available in the TFCI fields of one compressed radio frame by D and the number of bits in the TFCI field in a slot by N_{TFCI}. The parameter E is used to determine the position of the first bit in the TFCI field on which DTX is used.

$E = N_{first} N_{TFCI}$, if the start of the transmission gap is allocated to the current frame.
$E = 0$, if the start of the transmission gap is allocated to the previous frame and the end of the transmission gap is allocated to the current frame.

Denote the total number of TFCI bits to be transmitted by F. $F = 32$ for slot formats nA or nB, where $n = 0, 1, \ldots, 11$ (see table 11 in [2]). Otherwise, $F = 128$. The TFCI coded bits b_k are mapped to the bits in the TFCI fields d_k. The following relations define the mapping for each compressed frame.

If $E > 0$,

$$d_k = b_{k \bmod 32}$$

where $k = 0, 1, 2, \ldots, \min(E, F)-1$.

If $E < F$,

$$d_{k+D-F} = b_{k \bmod 32}$$

where $k = E, ..., F-1$.

DTX is used on d_k where $k = \min(E, F), ..., \min(E, F) + D - F - 1$.

4.4 Compressed mode

In compressed frames, TGL slots from N_{first} to N_{last} are not used for transmission of data. As illustrated in figure 11, the instantaneous transmit power is increased in the compressed frame in order to keep the quality (BER, FER, etc.) unaffected by the reduced processing gain. The amount of power increase depends on the transmission time reduction method (see subclause 4.4.3). What frames are compressed, are decided by the network. When in compressed mode, compressed frames can occur periodically, as illustrated in figure 11, or requested on demand. The rate and type of compressed frames is variable and depends on the environment and the measurement requirements.

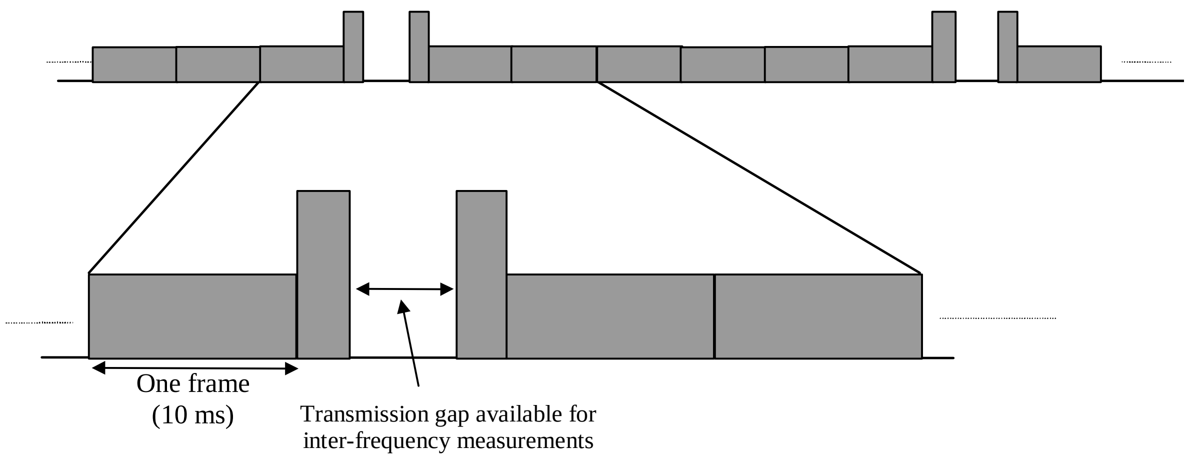


Figure 11: Compressed mode transmission

4.4.1 Frame structure in the uplink

The frame structure for uplink compressed frames is illustrated in figure 12.

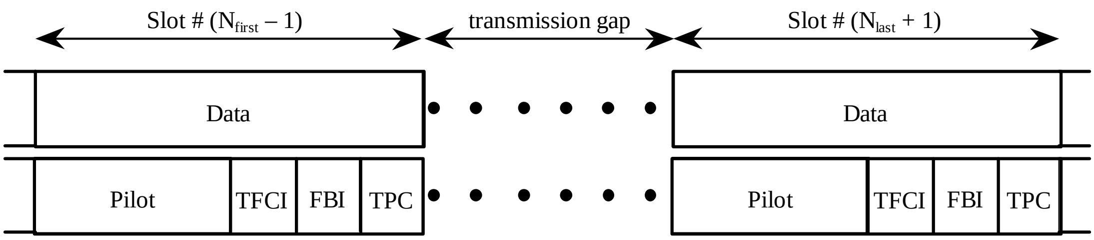


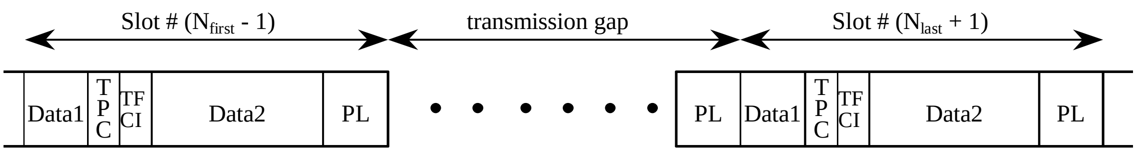
Figure 12: Frame structure in uplink compressed transmission

4.4.2 Frame structure types in the downlink

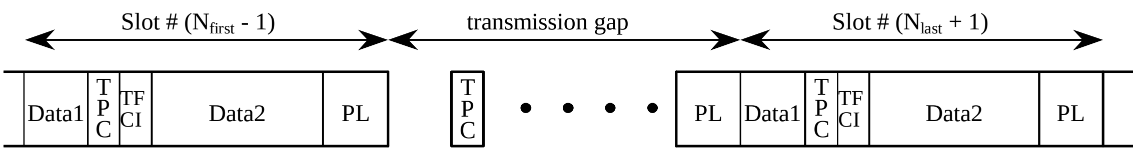
There are two different types of frame structures defined for downlink compressed frames. Type A maximises the transmission gap length and type B is optimised for power control. The frame structure type A or B is set by higher layers independent from the downlink slot format type A or B.

- With frame structure of type A, the pilot field of the last slot in the transmission gap is transmitted. Transmission is turned off during the rest of the transmission gap (figure 13(a)). In case the length of the pilot field is 2 bits and STTD is used on the radio link, the pilot bits in the last slot of the transmission gap shall be STTD encoded assuming DTX indicators as the two last bits in the Data2 field.

- With frame structure of type B, the TPC field of the first slot in the transmission gap and the pilot field of the last slot in the transmission gap is transmitted. Transmission is turned off during the rest of the transmission gap (figure 13(b)). In case the length of the pilot field is 2 bits and STTD is used on the radio link, the pilot bits in the last slot of the transmission gap shall be STTD encoded assuming DTX indicators as the two last bits of the Data2 field. Similarly, the TPC bits in the first slot of the transmission gap shall be STTD encoded assuming DTX indicators as the two last bits in the Data1 field.



(a) Frame structure type A



(b) Frame structure type B

Figure 13: Frame structure types in downlink compressed transmission

4.4.2A Frame structure in the downlink for F-DPCH

There is only one type of frame structure defined for downlink F-DPCH compressed frames: transmission is turned off during the whole transmission gap i.e. in slots N_{first} to N_{last}.

4.4.3 Transmission time reduction method

When in compressed mode, the information normally transmitted during a 10 ms frame is compressed in time. The mechanisms provided for achieving this are puncturing, reduction of the spreading factor by a factor of two , and higher layer scheduling. In the downlink and the uplink, all methods are supported while compressed mode by puncturing is not used in the uplink. The maximum idle length is defined to be 7 slots per one 10 ms frame. The slot formats that are used in compressed frames are listed in [2].

In case F-DPCH is configured in the downlink, no transmission time reduction method is needed during compressed frames. The same slot format is used in compressed frames and normal frames.

4.4.3.1 Compressed mode by puncturingVoid

Rate matching is applied for creating a transmission gap in one or two frames. The algorithm for rate matching as described in subclause 4.2.7 is used.

Annex B (informative): Compressed mode idle lengths

The tables B.1-B.3 show the resulting idle lengths for different transmission gap lengths, UL/DL modes and DL frame types when DPCCH/DPDCH are used in the uplink and DPCH in the downlink. The idle lengths given are calculated purely from the slot and frame structures and the UL/DL offset. They do not contain margins for e.g. synthesizer switching.

B.1 Idle lengths for DL, UL and DL+UL compressed mode for DPCH

Table B.1: Parameters for DL compressed mode

TGL	DL Frame Type	Spreading Factor	Idle length [ms]	Transmission time Reduction method	Idle frame Combining
3	A	512 – 4	1.73 – 1.99	~~Puncturing,~~ Spreading factor division by 2 or Higher layer scheduling	(S) (D) =(1,2) or (2,1)
	B		1.60 – 1.86		
4	A		2.40 – 2.66		(S) (D) =(1,3), (2,2) or (3,1)
	B		2.27 – 2.53		
5	A		3.07 – 3.33		(S) (D) = (1,4), (2,3), (3, 2) or (4,1)
	B		2.93 – 3.19		
7	A		4.40 – 4.66		(S) (D)=(1,6), (2,5), (3,4), (4,3), (5,2) or (6,1)
	B		4.27 – 4.53		
10	A		6.40 – 6.66		(D)=(3,7), (4,6), (5,5), (6,4) or (7,3)
	B		6.27 – 6.53		
14	A		9.07 – 9.33		(D) =(7,7)
	B		8.93 – 9.19		

Table B.2: Parameters for UL compressed mode

TGL	Spreading Factor	Idle length [ms]	Transmission time Reduction method	Idle frame Combining
3	256 – 4	2.00	Spreading factor division by 2 or Higher layer scheduling	(S) (D) =(1,2) or (2,1)
4		2.67		(S) (D) =(1,3), (2,2) or (3,1)
5		3.33		(S) (D) = (1,4), (2,3), (3, 2) or (4,1)
7		4.67		(S) (D)=(1,6), (2,5), (3,4), (4,3), (5,2) or (6,1)
10		6.67		(D)=(3,7), (4,6), (5,5), (6,4) or (7,3)
14		9.33		(D) =(7,7)

Table B.3: Parameters for combined UL/DL compressed mode

TGL	DL Frame Type	Spreading Factor	Idle length [ms]	Transmission time Reduction method	Idle frame Combining
3	A or B	DL: 512 – 4 UL: 256 – 4	1.47 – 1.73	~~DL:~~ ~~Puncturing,~~ Spreading factor division by 2 or Higher layer scheduling ~~UL:~~ ~~Spreading factor division by 2 or Higher layer scheduling~~	(S) (D) =(1,2) or (2,1)
4			2.13 – 2.39		(S) (D) =(1,3), (2,2) or (3,1)
5			2.80 – 3.06		(S) (D) = (1,4), (2,3), (3, 2) or (4,1)
7			4.13 – 4.39		(S) (D)=(1,6), (2,5), (3,4), (4,3), (5,2) or (6,1)
10			6.13 – 6.39		(D)=(3,7), (4,6), (5,5), (6,4) or (7,3)
14			8.80 – 9.06		(D) =(7,7)

(S): Single-frame method as shown in figure 14 (1).

(D): Double-frame method as shown in figure 14 (2). (x,y) indicates x: the number of idle slots in the first frame, y: the number of idle slots in the second frame.

NOTE: Compressed mode by spreading factor reduction is not supported when SF=4 is used in normal mode

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CHANGE REQUEST

⌘ **25.214**	**CR 388**	⌘**rev**	**-** ⌘	Current version:	**5.10.0** ⌘

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

Title: ⌘	Feature clean up: Removal of the 'compressed mode by puncturing'		
Source: ⌘	RAN WG1		
Work item code: ⌘	TEI5	***Date:*** ⌘	18/04/2005
Category: ⌘	**C** *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.	***Release:*** ⌘	Rel-5 *Use one of the following releases:* *Ph2 (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)* *Rel-7 (Release 7)*

Reason for change: ⌘	RAN #27 decision in RP-050144 to remove the feature 'CM by puncturing'.
Summary of change: ⌘	Text regarding Compressed Mode by puncturing is removed. Minor editorial changes are made to improve consistency.
Consequences if not approved: ⌘	The RAN #27 decision would be violated.

Clauses affected: ⌘	5.2.1.3				
	Y	**N**			
Other specs ⌘	X		Other core specifications	⌘	25.101, 25.133, 25.211, 25.212, 25.215, 25.331, 25.423, 25.433
affected:			Test specifications		
		X	O&M Specifications		
Other comments: ⌘	Contents of this CR is unchanged compared to R1-050479.				

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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.

5.2.1.3 Power control in compressed mode

The aim of downlink power control in uplink or/and downlink compressed mode is to recover as fast as possible a signal-to-interference ratio (SIR) close to the target SIR after each transmission gap.

The UE behaviour is the same in compressed mode as in normal mode, described in subclause 5.2.1.2, except that the target SIR is offset by higher layer signalling. However due to transmission gaps in uplink compressed frames there may be incomplete sets of TPC commands when DPC_MODE=1.

UTRAN behaviour is as stated in section 5.2.1.2.2 except for DPC_MODE = 1 where missing TPC commands in the UL may lead the UTRAN to changing its power more frequently than every 3 slots.

In compressed mode, compressed frames may occur in either the uplink or the downlink or both. In downlink compressed frames, the transmission of downlink DPDCH(s) and DPCCH shall be stopped during transmission gaps.

The power of the DPCCH and DPDCH in the first slot after the transmission gap should be set to the same value as in the slot just before the transmission gap.

During compressed mode except during downlink transmission gaps, UTRAN shall estimate the k:th TPC command and adjust the current downlink power $P(k-1)$ [dB] to a new power $P(k)$ [dB] according to the following formula:

$$P(k) = P(k - 1) + P_{TPC}(k) + P_{SIR}(k) + P_{bal}(k),$$

where $P_{TPC}(k)$ is the k:th power adjustment due to the inner loop power control, $P_{SIR}(k)$ is the k-th power adjustment due to the downlink target SIR variation, and $P_{bal}(k)$ [dB] is a correction according to the downlink power control procedure for balancing radio link powers towards a common reference power. The power balancing procedure and control of the procedure is described in [6].

Due to transmission gaps in uplink compressed frames, there may be missing TPC commands in the uplink.

For DPC_MODE = 0 if no uplink TPC command is received, $P_{TPC}(k)$ derived by the Node B shall be set to zero. Otherwise, $P_{TPC}(k)$ is calculated the same way as in normal mode (see sub-clause 5.2.1.2.2) but with a step size Δ_{STEP} instead of Δ_{TPC}.

For DPC_MODE = 1, the sets of slots over which the TPC commands are processed shall remain aligned to the frame boundaries in the compressed frame. If this results in an incomplete set of TPC commands, the UE shall transmit the same TPC commands in all slots of the incomplete set.

The power control step size $\Delta_{STEP} = \Delta_{RP-TPC}$ during RPL slots after each transmission gap and $\Delta_{STEP} = \Delta_{TPC}$ otherwise, where:

- RPL is the recovery period length and is expressed as a number of slots. RPL is equal to the minimum value out of the transmission gap length and 7 slots. If a transmission gap is scheduled to start before RPL slots have elapsed, then the recovery period shall end at the start of the gap, and the value of RPL shall be reduced accordingly.

- Δ_{RP-TPC} is called the recovery power control step size and is expressed in dB. Δ_{RP-TPC} is equal to the minimum value of 3 dB and $2\Delta_{TPC}$.

The power offset $P_{SIR}(k) = \delta P_{curr} - \delta P_{prev}$, where δP_{curr} and δP_{prev} are respectively the value of δP in the current slot and the most recently transmitted slot and δP is computed as follows:

$$\delta P = \max(\Delta P1\_compression, \ldots, \Delta Pn\_compression) + \Delta P1\_coding + \Delta P2\_coding$$

where n is the number of different TTI lengths amongst TTIs of all TrChs of the CCTrCh, where ΔP1_coding and ΔP2_coding are computed from uplink parameters DeltaSIR1, DeltaSIR2, DeltaSIRafter1, DeltaSIRafter2 signaled by higher layers as:

- ΔP1_coding = DeltaSIR1 if the start of the first transmission gap in the transmission gap pattern is within the current frame.

- ΔP1_coding = DeltaSIRafter1 if the current frame just follows a frame containing the start of the first transmission gap in the transmission gap pattern.

- ΔP2_coding = DeltaSIR2 if the start of the second transmission gap in the transmission gap pattern is within the current frame.

- ΔP2_coding = DeltaSIRafter2 if the current frame just follows a frame containing the start of the second transmission gap in the transmission gap pattern.

- ΔP1_coding = 0 dB and ΔP2_coding = 0 dB in all other cases.

and ΔPi_compression is defined by :

- ΔPi_compression = 3 dB for downlink frames compressed by reducing the spreading factor by 2.

- ~~ΔPi_compression = 10 log ($15*F_i$ / ($15*F_i$ – TGL_i)) if there is a transmission gap created by puncturing method within the current TTI of length F_i frames, where TGL_i is the gap length in number of slots (either from one gap or a sum of gaps) in the current TTI of length F_i frames.~~

- ΔPi_compression = 0 dB in all other cases.

In case several compressed mode patterns are used simultaneously, a δP offset is computed for each compressed mode pattern and the sum of all δP offsets is applied to the frame.

For all time slots except those in transmissions gaps, the average power of transmitted DPDCH symbols over one timeslot shall not exceed Maximum_DL_Power (dB) by more than δP_{curr}, nor shall it be below Minimum_DL_Power (dB). Transmitted DPDCH symbol means here a complex QPSK symbol before spreading which does not contain DTX. Maximum_DL_Power (dB) and Minimum_DL_Power (dB) are power limits for one channelisation code, relative to the primary CPICH power [6].

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Athens, Greece, 9 - 13 May 2005

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CHANGE REQUEST

⌘	**25.214**	**CR**	**389**	⌘**rev**	**-**	⌘	Current version:	**6.5.0**	⌘

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

Title:	⌘	Feature clean up: Removal of the 'compressed mode by puncturing'
Source:	⌘	RAN WG1
Work item code:	⌘	TEI6
Date:	⌘	18/04/2005
Category:	⌘	**C**
Release:	⌘	Rel-6

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:
Ph2 (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)
Rel-7 (Release 7)

Reason for change:	⌘	RAN #27 decision in RP-050144 to remove the feature 'CM by puncturing'.
Summary of change:	⌘	Text regarding Compressed Mode by puncturing is removed. Minor editorial changes are made to improve consistency.
Consequences if not approved:	⌘	The RAN #27 decision would be violated.

Clauses affected:	⌘	5.2.1.3				
		Y	**N**			
Other specs affected:	⌘	X		Other core specifications	⌘	25.101, 25.133, 25.211, 25.212, 25.215, 25.331, 25.423, 25.433
				Test specifications		
			X	O&M Specifications		
Other comments:	⌘	Contents of this CR is unchanged compared to R1-050479.				

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5.2.1.3 Power control in compressed mode

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The UE behaviour is the same in compressed mode as in normal mode, described in subclause 5.2.1.2, except that the target SIR for a DPCH is offset by higher layer signalling. However due to transmission gaps in uplink compressed frames there may be incomplete sets of TPC commands when DPC_MODE=1.

UTRAN behaviour is as stated in section 5.2.1.2.2 except for DPC_MODE = 1 where missing TPC commands in the UL may lead the UTRAN to changing its power more frequently than every 3 slots.

In compressed mode, compressed frames may occur in either the uplink or the downlink or both. In downlink compressed frames, the transmission of downlink DPDCH(s), DPCCH and F-DPCH shall be stopped during transmission gaps.

The power of the DPCCH and DPDCH in the first slot after the transmission gap, or the power of the F-DPCH in the first slot after the transmission gap, should be set to the same value as in the slot just before the transmission gap.

During compressed mode except during downlink transmission gaps, UTRAN shall estimate the k:th TPC command and adjust the current downlink power $P(k\text{-}1)$ [dB] to a new power $P(k)$ [dB] according to the following formula:

$$P(k) = P(k - 1) + P_{TPC}(k) + P_{SIR}(k) + P_{bal}(k),$$

where $P_{TPC}(k)$ is the k:th power adjustment due to the inner loop power control, $P_{SIR}(k)$ is the k-th power adjustment due to the downlink target SIR variation, and $P_{bal}(k)$ [dB] is a correction according to the downlink power control procedure for balancing radio link powers towards a common reference power. The power balancing procedure and control of the procedure is described in [6].

Due to transmission gaps in uplink compressed frames, there may be missing TPC commands in the uplink.

For DPC_MODE = 0 if no uplink TPC command is received, $P_{TPC}(k)$ derived by the Node B shall be set to zero. Otherwise, $P_{TPC}(k)$ is calculated the same way as in normal mode (see sub-clause 5.2.1.2.2) but with a step size Δ_{STEP} instead of Δ_{TPC}.

For DPC_MODE = 1, the sets of slots over which the TPC commands are processed shall remain aligned to the frame boundaries in the compressed frame. If this results in an incomplete set of TPC commands, the UE shall transmit the same TPC commands in all slots of the incomplete set.

The power control step size $\Delta_{STEP} = \Delta_{RP\text{-}TPC}$ during RPL slots after each transmission gap and $\Delta_{STEP} = \Delta_{TPC}$ otherwise, where:

- RPL is the recovery period length and is expressed as a number of slots. RPL is equal to the minimum value out of the transmission gap length and 7 slots. If a transmission gap is scheduled to start before RPL slots have elapsed, then the recovery period shall end at the start of the gap, and the value of RPL shall be reduced accordingly.

- $\Delta_{RP\text{-}TPC}$ is called the recovery power control step size and is expressed in dB. $\Delta_{RP\text{-}TPC}$ is equal to the minimum value of 3 dB and $2\Delta_{TPC}$.

For F-DPCH, $P_{SIR}(k) = 0$.

For DPCH, the power offset $P_{SIR}(k) = \delta P_{curr} - \delta P_{prev}$, where δP_{curr} and δP_{prev} are respectively the value of δP in the current slot and the most recently transmitted slot and δP is computed as follows:

$$\delta P = \max(\Delta P1\_compression, \ldots, \Delta Pn\_compression) + \Delta P1\_coding + \Delta P2\_coding$$

where n is the number of different TTI lengths amongst TTIs of all TrChs of the CCTrCh, where ΔP1_coding and ΔP2_coding are computed from uplink parameters DeltaSIR1, DeltaSIR2, DeltaSIRafter1, DeltaSIRafter2 signaled by higher layers as:

- ΔP1_coding = DeltaSIR1 if the start of the first transmission gap in the transmission gap pattern is within the current frame.

- ΔP1_coding = DeltaSIRafter1 if the current frame just follows a frame containing the start of the first transmission gap in the transmission gap pattern.

- ΔP2_coding = DeltaSIR2 if the start of the second transmission gap in the transmission gap pattern is within the current frame.

- ΔP2_coding = DeltaSIRafter2 if the current frame just follows a frame containing the start of the second transmission gap in the transmission gap pattern.

- ΔP1_coding = 0 dB and ΔP2_coding = 0 dB in all other cases.

and ΔPi_compression is defined by :

- ΔPi_compression = 3 dB for downlink frames compressed by reducing the spreading factor by 2.

- ~~ΔPi_compression = 10 log (15*F_i / (15*F_i – TGL_i)) if there is a transmission gap created by puncturing method within the current TTI of length F_i frames, where TGL_i is the gap length in number of slots (either from one gap or a sum of gaps) in the current TTI of length F_i frames.~~

- ΔPi_compression = 0 dB in all other cases.

In case several compressed mode patterns are used simultaneously, a δP offset is computed for each compressed mode pattern and the sum of all δP offsets is applied to the frame.

For all time slots except those in transmissions gaps, the average power of transmitted DPDCH symbols over one timeslot shall not exceed Maximum_DL_Power (dB) by more than δP_{curr}, nor shall it be below Minimum_DL_Power (dB). Transmitted DPDCH symbol means here a complex QPSK symbol before spreading which does not contain DTX. Maximum_DL_Power (dB) and Minimum_DL_Power (dB) are power limits for one channelisation code, relative to the primary CPICH power [6].

For F-DPCH, for all time slots except those in transmissions gaps the power of the transmitted symbol over one timeslot for a given UE shall not exceed Maximum_DL_Power (dB), nor shall it be below Minimum_DL_Power (dB). Transmitted symbol means here a complex QPSK symbol before spreading which does not contain DTX.

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CHANGE REQUEST

⌘	**25.215**	**CR 164**	⌘ **rev**	**-**	⌘ Current version:	**5.6.0** ⌘

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

Title:	⌘	Feature clean up: Removal of the 'compressed mode by puncturing'		
Source:	⌘	RAN WG1		
Work item code:	⌘	TEI5	***Date:*** ⌘	18/04/2005
Category:	⌘	**C** *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.	***Release:*** ⌘	Rel-5 *Use one of the following releases:* *Ph2 (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)* *Rel-7 (Release 7)*

Reason for change:	⌘	The feature 'compressed mode by puncturing' is not used in real networks. Furthermore, as compressed mode by puncturing is only applicable for fixed positions in DL, it not expected to be the best way of handling compressed mode measurements with future services. RAN #27 decided with RP-050144 to remove this feature.
Summary of change:	⌘	The method for generating the downlink compressed mode gap by puncturing is removed.
Consequences if not approved:	⌘	Simplification of specifications, reduction of complexity and easier evolution chance would be missed and a RAN #27 decision would be violated.

Clauses affected:	⌘	6.1.1.2				
		Y	**N**			
Other specs	⌘	**X**		Other core specifications	⌘	25.101, 25.133, 25.211, 25.212, 25.214, 25.331, 25.423, 25.433
affected:				Test specifications		
			X	O&M Specifications		
Other comments:	⌘	Contents of this CR is unchanged compared to R1-050479.				

How to create CRs using this form:

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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.

6.1.1 Compressed mode

6.1.1.1 Use of compressed mode for monitoring

On command from the UTRAN, a UE shall monitor cells on other FDD frequencies and on other modes and radio access technologies that are supported by the UE (i.e. TDD, GSM). To allow the UE to perform measurements, UTRAN shall command that the UE enters in compressed mode, depending on the UE capabilities.

The UE capabilities define whether a UE requires compressed mode in order to monitor cells on other FDD frequencies and on other modes and radio access technologies. UE capabilities indicate the need for compressed mode separately for the uplink and downlink and for each mode, radio access technology and frequency band.

A UE shall support compressed mode for all cases for which the UE indicates that compressed mode is required.

A UE does not need to support compressed mode for cases for which the UE indicates that compressed mode is not required. For these cases, the UE shall support an alternative means of making the measurements.

The UE shall support one single measurement purpose for one transmission gap pattern sequence. The measurement purpose of the transmission gap pattern sequence is signalled by higher layers.

The following subclause provides rules to parameterise the compressed mode.

6.1.1.2 Parameterisation of the compressed mode

In response to a request from higher layers, the UTRAN shall signal to the UE the compressed mode parameters.

A transmission gap pattern sequence consists of consecutive occurrences of transmission gap pattern 1, where transmission gap pattern 1 consists of one or two transmission gaps. See figure 1.

The following parameters characterise a transmission gap pattern:

- TGSN (Transmission Gap Starting Slot Number): A transmission gap pattern begins in a radio frame, henceforward called first radio frame of the transmission gap pattern, containing at least one transmission gap slot. TGSN is the slot number of the first transmission gap slot within the first radio frame of the transmission gap pattern;
- TGL1 (Transmission Gap Length 1): This is the duration of the first transmission gap within the transmission gap pattern, expressed in number of slots;
- TGL2 (Transmission Gap Length 2): This is the duration of the second transmission gap within the transmission gap pattern, expressed in number of slots. If this parameter is not explicitly set by higher layers, then TGL2 = TGL1;
- TGD (Transmission Gap start Distance): This is the duration between the starting slots of two consecutive transmission gaps within a transmission gap pattern, expressed in number of slots. The resulting position of the second transmission gap within its radio frame(s) shall comply with the limitations of [2]. If this parameter is not set by higher layers, then there is only one transmission gap in the transmission gap pattern;
- TGPL1 (Transmission Gap Pattern Length): This is the duration of transmission gap pattern 1, expressed in number of frames.

The following parameters control the transmission gap pattern sequence start and repetition:

- TGPRC (Transmission Gap Pattern Repetition Count): This is the number of transmission gap patterns within the transmission gap pattern sequence;
- TGCFN (Transmission Gap Connection Frame Number): This is the CFN of the first radio frame of the first pattern 1 within the transmission gap pattern sequence.

In addition to the parameters defining the positions of transmission gaps, each transmission gap pattern sequence is characterised by:

- UL/DL compressed mode selection: This parameter specifies whether compressed mode is used in UL only, DL only or both UL and DL;

- UL compressed mode method: The methods for generating the uplink compressed mode gap are spreading factor division by two or higher layer scheduling and are described in [2];
- DL compressed mode method: The methods for generating the downlink compressed mode gap are ~~puncturing,~~ spreading factor division by two or higher layer scheduling and are described in [2];
- downlink frame type: This parameter defines if frame structure type 'A' or 'B' shall be used in downlink compressed mode. The frame structures are defined in [2];
- scrambling code change: This parameter indicates whether the alternative scrambling code is used for compressed mode method 'SF/2'. Alternative scrambling codes are described in [3];
- RPP: Recovery Period Power control mode specifies the uplink power control algorithm applied during recovery period after each transmission gap in compressed mode. RPP can take 2 values (0 or 1). The different power control modes are described in [4];
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- FDD
- TDD
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- Initial BSIC identification
- BSIC re-confirmation.

The UE shall support one compressed mode pattern sequence for each measurement purpose while operating in FDD mode, assuming the UE needs compressed mode to perform the respective measurement. In case the UE supports several of the measurement purposes, it shall support in parallel one compressed mode pattern sequence for each supported measurement purpose where the UE needs compressed mode to perform the measurement. The capability of the UE to operate in compressed mode in uplink and downlink is given from the UE capabilities.

The GSM measurements Initial BSIC identification and BSIC re-confirmation are defined in [20].

Higher layers will ensure that the compressed mode gaps do not overlap and are not scheduled to overlap the same frame. The behaviour when an overlap occurs is described in [11]. UE is not required to support two compressed mode gaps in a frame.

In all cases, higher layers have control of individual UE parameters. Any pattern sequence can be stopped on higher layers' command.

The parameters TGSN, TGL1, TGL2, TGD, TGPL1, TGPRC and TGCFN shall all be integers.

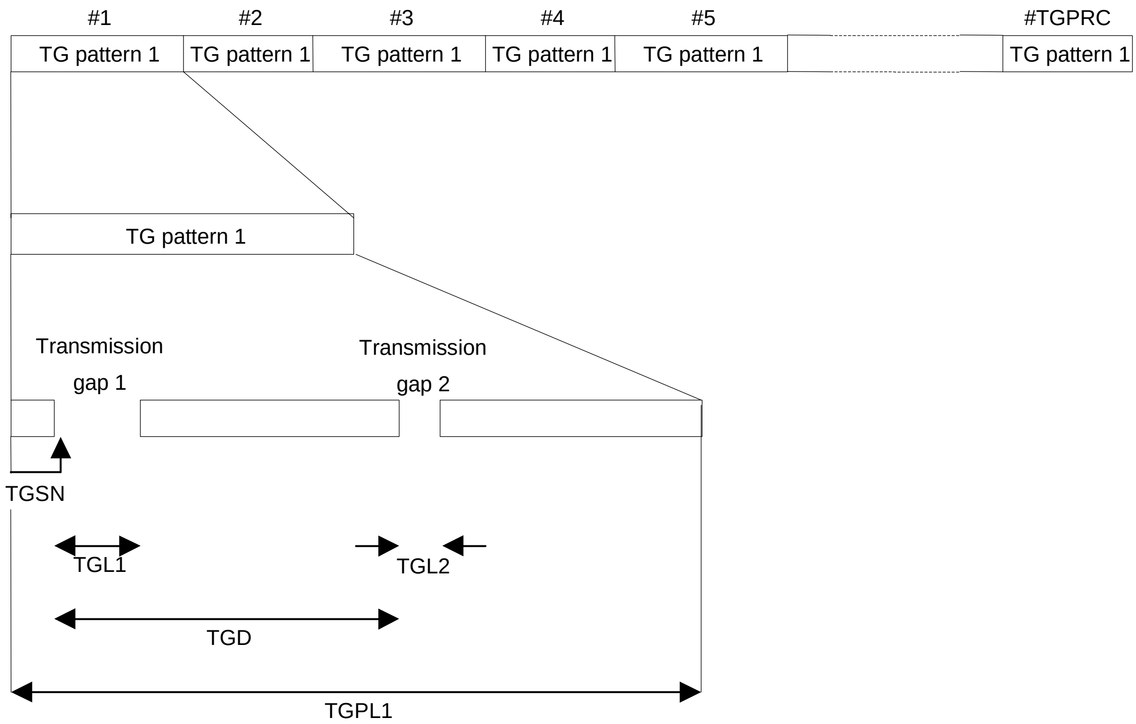

Figure 1: Illustration of compressed mode pattern parameters

3GPP TSG RAN WG1 Meeting #41
Athens, Greece, May 9-13, 2005

Tdoc ⌘R1-050525

CR-Form-v7.1

CHANGE REQUEST

⌘	**25.215**	**CR**	**165**	⌘ **rev**	**-**	⌘	Current version:	**6.2.0**	⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

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

Title:	⌘	Feature clean up: Removal of the 'compressed mode by puncturing'
Source:	⌘	RAN WG1
Work item code:	⌘	TEI6
Date:	⌘	18/04/2005
Category:	⌘	**C**
Release:	⌘	Rel-6

Use one of the following categories:
- ***F*** *(correction)*
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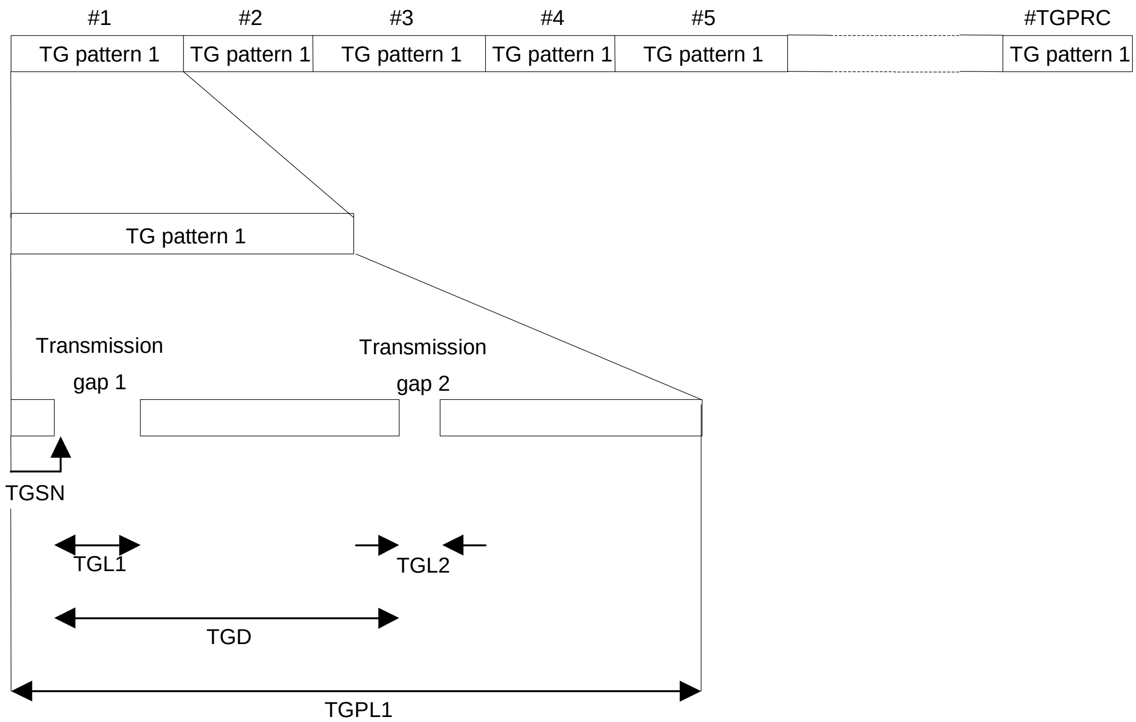

Figure 1: Illustration of compressed mode pattern parameters