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1 Introduction

Uplink compressed mode should at least be supported by UEs that monitor frequencies that are close to the uplink transmission frequency (i.e. frequencies in the TDD or GSM 1800/1900 bands) [1]. Currently there is no description of uplink compressed mode in [2]. In this paper it is proposed that compressed mode in uplink should be obtained by reducing the spreading factor by two.

Two transmission time reduction methods for downlink compressed mode are supported in [2]. Either the coding rate can be increased or the spreading factor decreased by a factor of two. The first method is referred to as method A and the latter as method B. Method A is further divided into method A1 and A2. Method A1 utilize increased coding rate during one radio frame while method A2 increase the coding rate during several radio frames. Unfortunately, neither A1 nor A2 is sufficiently described in [2]. In [3], it was proposed that method A1 should achieve transmission gaps by additional puncturing before 2nd interleaving. However, it is unclear how the performance is affected when the puncturing is performed in two independent steps. Further, method A1 is only intended for obtaining transmission gap lengths (TGLs) up to 4 slots [2] and it can for example not be used if a transport channel is uncoded. For method A2 there are so many things missing in the description that it seems unlikely that it will be included in release 99. Consequently, method A alone can not be used for obtaining compressed mode.

With method B, the spreading factor is reduced by a factor two and the physical channel rate therefore doubled. One disadvantage with method B is that it does not work in code limited scenarios. Another problem is that the UE in uncompressed mode can not receive at the highest physical channel rate that it supports since the highest physical channel rate is needed for compressed mode. At the last WG1 meeting it was proposed [4] and agreed that it also should be possible to use method B in code limited scenarios by utilizing a different scrambling code in compressed mode. Consequently, the first problem of method B was removed. The second problem does not seem possible to solve and method B will have to be used together with some other method if compressed mode should be guaranteed for all scenarios.

When reducing the spreading factor by a factor two, a transmission gap of 7.5 slots is obtained. A detailed description of method B is currently missing in [2] and it is not clear if method B can be used to obtain transmission gaps shorter than 7.5 slots. In this paper it is proposed that it should be possible to use DTX to enable transmission gaps shorter than 7.5 slots with method B. Even if method A1 can be used to obtain slots shorter than 7.5 slots, it may be beneficial from a performance point of view to use method B.

2 Uplink compressed mode

2.1 Transmission time reduction method

The need for uplink compressed mode has been identified [1] but no method for obtaining it has so far been proposed. The applicability of the downlink methods A and B to uplink is discussed below.

2.1.1 Method A: Increased coding rate for the TrCHs in the CCTrCH

The current assumption is that by increasing the coding rate from 1/3 to 1/2 on the transport channels (TrCHs) in the coded composit TrCH (CCTrCH) and increasing the power, the performance on the radio link can be maintained. The change in coding rate would be done by additional puncturing. In the downlink, rate matching is performed on transmission time interval basis and there is a risk that additional puncturing on radio frame basis results in poor performance. In uplink, rate matching is performed on radio frame basis and additional puncturing could therefore be incorporated in the rate matching block. The risk of poor performance due to additional puncturing would then be minimized.

Unfortunately, this method can not be used for all possible cases. It is expected that poor performance will result if extensive puncturing is applied to rate 1/2 encoded transport channels. Further, the method can only achieve transmission gaps up to 4 slots (0.33*15slots = 4.95 slots) with current restrictions in [2].

2.1.2 Method B: Reduction of spreading factor for the DPDCHs

The number of available bits on the physical channel is doubled if the spreading factor is reduced by a factor two. In downlink this method may slightly increase the interference in code limited scenarios since additional non-orthogonal scrambling codes are used. In uplink this is not a problem since the number of available orthogonal codes is large.

However, two problems remain to be solved. First issue that needs to be addressed is the peak output power in the UE. When the spreading factor is reduced by a factor of two, the power must be increased to maintain the same performance on the radio link. This means that using compressed mode will increase the peak output power in the UE. Transmission gaps of 3, 4, 5, and 7 slots in a radio frame are currently supported in [2]. If the spreading factor is reduced by a factor of two, then the available transmission gap is 7.5 slots. This means that for all cases the obtained transmission gap is longer than necessary and higher peak output power than necessary will be required.

The second issue that need be solved is what to do when the UE already is transmitting with its maximum capability. For example a UE that does not support multicode and is already transmitting on spreading factor 4 in uncompressed mode.

2.1.3 Proposed solution for DPDCHs

No simple solution to the restrictions of method A has been identified and it is therefore proposed that method B is used with the following modification. In order not to increase the output more than necessary it is proposed that after the spreading factor has been reduced by a factor two, repetition (or reduction of puncturing) is used to obtain exactly the transmission gap length needed. The power will then not have to be increased more than necessary. This can easily be incorporated into the current uplink rate matching algorithm since rate matching is performed on radio frame basis.

The number of bits, ΔN_{ij}, to repeat or puncture for transport channel *i* and transport format combination (TFC) *j* is calculated as [2]:

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

$$Z_{ij} = \left\lfloor \frac{\sum_{m=1}^{i} RM_m \cdot N_{mj}}{\sum_{m=1}^{I} RM_m \cdot N_{mj}} \cdot N_{data,j} \right\rfloor$$ for all *i* = 1 .. *I, where ë û means round downwards*

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

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

ΔN_{ij} If positive - number of bits that should be repeated in each radio frame on TrCH *i* with TFC *j*.

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

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

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

I: Number of TrCHs in the CCTrCH.

Z_{ij}: Intermediate calculation variable.

The following parameters are currently used to describe the position of the transmission gap:

N_{first} The first slot in the transmission gap. Slots are numbered 0-14.

N_{last} The last slot in the transmission gap. Note that this slot can be both in the same radio frame as N_{first} and in frame directly following the frame that contains N_{first}.

TGL Transmission gap length in slots, $0 \leq TGL \leq 14$

Using the above notation, the length of the transmission gap in bits, N_{TGL}, can then be calculated as:

$$N_{TGL} = \begin{cases} \frac{TGL}{15} 2N_{data,j}, \text{ if } N_{first} + TGL \leq 15 \\ \frac{15 - N_{first}}{15} 2N_{data,j}, \text{ in first frame if } N_{first} + TGL > 15 \\ \frac{TGL - (15 - N_{first})}{15} 2N_{data,j}, \text{ in second frame if } N_{first} + TGL > 15 \end{cases}$$

If $N_{data,j}$ is replaced by $N_{data,j}^{cm}$ in the “Z -fomula” above where $N_{data,j}^{cm} = 2N_{data,j} - N_{TGL}$, then the rate matching also takes care of the additional rate matching proposed for compressed mode.

The method can be illustrated with an example. Consider the transmission gap illustrated in Figure 1

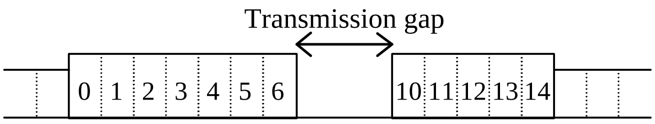


Figure 1: TGL=3 with SF/2 method

If for example SF 64 is used for TFC *J*, then $N_{data,J} = 600$ [5]. Using above relations $N_{TGL} = 240$ and $N_{data,J}^{cm} = 960$, i.e. repetition is used to fit the 600 bits onto a physical channel (PhCH) with 960 bits. If puncturing was used to fit the bits to the 600 bits PhCH then the puncturing is decreased. The point is that it is a one step operation, puncturing is not first performed and some other bits later repeated.

Note that method B with additional repetition, in principle also could be used together with multicode. Instead of reducing the spreading factor, the number of codes would be doubled. Solutions with only one additional code instead of doubling would also be possible but make the rules more complicated.

The second problem was enabling compressed mode when the UE is already transmitting on spreading factor 4. It is expected that mainly packet service will require spreading factor 4 or multicode. With packet services, higher layers can schedule the transport blocks so that layer 1 receives fewer bits in transmission time intervals that will be sent in compressed radio frames.

2.2 Frame structure of the DPCCH

During the transmission gap both the DPDCH and the DPCCH must be turned off (illustrated in Figure 2), i.e. the number of TFCI bits per radio frame is reduced.

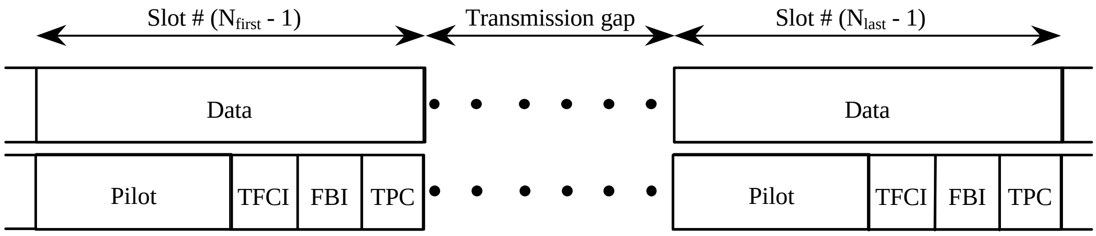


Figure 2: Frame structure in uplink compressed mode.

The TFCI is crucial to the detection at the receiver and extensive puncturing of TFCI bits must therefore be avoided. In downlink the problem is solved by modifying the frame formats in compressed mode. That means that the TFCI bits are sent in the DPDCH instead. In uplink this is not possible since the spreading factor is varying on the DPDCH. The spreading factor is not know until the TFCI has been decoded and consequently it is not possible to send the TFCI in the DPDCH. Throwing away (puncturing) the TFCI bits in the transmission gap is likely to give poor performance on the TFCI detection. There are then at least two possibilities. The spreading factor can be reduced by a factor 2 or the frame format in compressed mode modified. The two alternatives are discussed below.

2.2.1 Reducing the SF of the DPCCH

Reducing the spreading factor by two means that the number of bits in all DPCCH fields will be doubled. The power of the DPCCH must then be increased to maintain the performance of the radio link. This is needed for the TFCI since the same amount of information should be sent in half the number of slots. For the other fields the amount of “information” is unchanged but their power is increased since the power level of all DPCCH fields is the same in uplink. This power increase for pilot, TPC, and FBI fields will increase the overhead.

If rate matching is used on the DPDCH so that the transmission gap is of exactly the desired length (not 7.5 slots), then the DPCCH can carry more TFCI bits than needed. There is for example room for 10 more TFCI bits if only 5 slots are needed for measurements and the spreading factor has been reduced by two. This could be solved with repetition or dummy bits could be sent.

2.2.2 Changing the frame format of the DPCCH

The currently supported frame formats are given in Table 1 [5].

Format number	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{pilot}	N_{TPC}	N_{TFCI}	N_{FBI}
0	15	15	256	150	10	6	2	2	0
1	15	15	256	150	10	8	2	0	0
2	15	15	256	150	10	5	2	2	1
3	15	15	256	150	10	7	2	0	1
4	15	15	256	150	10	6	2	0	2
5	15	15	256	150	10	5	1	2	2

Table 1: DPCCH fields

Only the formats that include TFCI bits need to be changed during compressed mode, i.e. format 0, 2, and 5. Generally speaking, the number of idle slots in one radio frame is 1-7 slots. The closest numbers of TFCI bits per slot are listed in Table 2 for different numbers of used slots in one frame during compressed mode.

Transmitted slots	TFCI bits per slot	TFCI bits per frame
15	2	30
14	3	42
13	3	39
12	3	36
11	3	33
10	3	30
9	4	36
8	4	32

Table 2: Number of TFCI bits per slot needed for different number of transmitted slots

Transmission in 13 and 14 slots is currently only supported when the transmission gap spans two consecutive radio frames [2] and it is therefore not expected that these cases will be the most common ones. If these two cases are disregarded, there is at most room for 6 more bits than needed. It is proposed that these bits are a simple repetition of the bits directly following the transmission gap. Repetition should of course also be used for transmission of 13 and 14 slots. The point is that in most cases the number of extra bits will be limited and a simple repetition scheme can therefore be used. The slots directly after the transmission gap suffers from slightly worse power control and it is therefore beneficial to repeat the TFCI bits in these slots. If the transmission gap covers the last slots in the radio frame then it is of less importance what bits are repeated.

Denote the TFCI bits by c_{29}, c_{28}, c_{27}, …, c_0, the extra bits by $d_{D\text{-}31}$, $d_{D\text{-}32}$, .., d_0, where D is the number of available TFCI bits in the compressed frame. The first TFCI bit in slot after the transmission gap is denoted by c_E, i.e. $E = 29 - (N_{first} N_{TFCI}) \bmod 30$. The repeated bits are defined as $d_{D-31} = c_{E \bmod 30}, d_{D-32} = c_{(E-1) \bmod 30}, d_{D-33} = c_{(E-2) \bmod 30}, \ldots, d_0 = c_{(E-(D-30)) \bmod 30}$. The bits c_k are then mapped to the TFCI fields in descending order followed by d_k in descending order, i.e. c_{29} is sent in the first slot and d_0 in the last slot.

An example when the TGL is 4 slots and with different transmission gap positions (as illustrated in Figure 3) is given below.

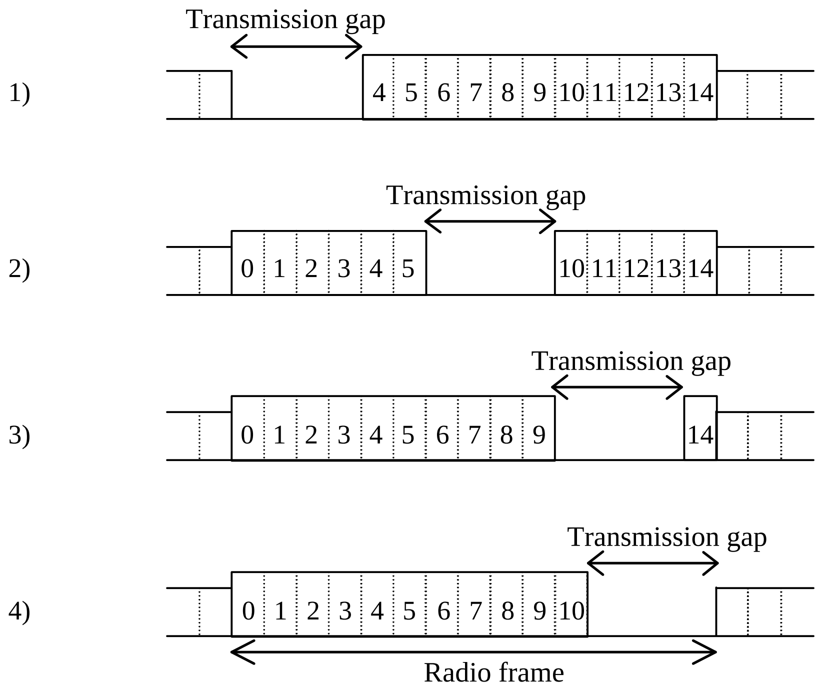


Figure 3: Example of transmission gap positions

Example

$D = 33$

1) $E = 29 - 0 = 29$ and $d_2 = c_{29}$, $d_1 = c_{28}$, $d_0 = c_{27}$

2) $E = 29 - 18 = 11$ and $d_2 = c_{11}$, $d_1 = c_{10}$, $d_0 = c_9$

3) $E = 29 - 30\text{mod}30 = 29$ and $d_2 = c_{29}$, $d_1 = c_{28}$, $d_0 = c_{27}$

4) $E = 29 - 33\text{mod}30 = 26$ and $d_2 = c_{26}$, $d_1 = c_{25}$, $d_0 = c_{24}$

The proposed table with the additional frame formats is given below.

Format number	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{pilot}	N_{TPC}	N_{TFCI}	N_{FBI}	Transmitted slots per frame
0	15	15	256	150	10	6	2	2	0	15
0A	15	15	256	150	10	5	2	3	0	10-14
0B	15	15	256	150	10	4	2	4	0	8-9
1	15	15	256	150	10	8	2	0	0	8-15
2	15	15	256	150	10	5	2	2	1	15
2A	15	15	256	150	10	4	2	3	1	10-14
2B	15	15	256	150	10	3	2	4	1	8-9
3	15	15	256	150	10	7	2	0	1	8-15
4	15	15	256	150	10	6	2	0	2	8-15
5	15	15	256	150	10	5	1	2	2	15
5A	15	15	256	150	10	4	1	3	2	10-14
5B	15	15	256	150	10	3	1	4	2	8-9

Table 3: Proposed table with DPCCH fields

2.2.3 Comparison of SF reduction and additional frame formats

If the SF of the DPCCH is reduced by a factor of two, only one additional frame format is needed for each frame format that includes TFCI. This extra frame format could easily be derived from the original one by multiplying the number of bits in each field by two. If instead two additional frame formats are added for each frame format with TFCI field, as described in Section 2.2.2, more memory is needed for storage but the increase in output power is lower.

For SF reduction the power of the DPCCH must be doubled since twice as many TFCI bits are sent in each slot. With the alternative solution, the TFCI field is extended on the expense of the pilot field and the power only need to be increased so that the total pilot power is kept constant. If the power in uncompressed mode is P, then the power needs to be increased to $6/5P$ for format 0A. This should be compared with $2P$ for the SF reduction method. The power of the DPCCH is expected to be in the order of 3 dB less than the power of the DPDCH for low bit rate CCTrCHs. The difference in total power between the two methods can then be calculated for format 0A with 3 idle slots as

$$10\log\frac{\frac{15}{12}2P+2P}{\frac{15}{12}2P+\frac{6}{5}P}\approx 0.85\,\text{dB}.$$

This of course corresponds to a maximum gain. For higher number of idle slots and formats with shorter pilot the difference will be smaller. Format 2B with 4 idle slots results in

$$10 \log \frac{\frac{15}{11} 2P + 2P}{\frac{15}{11} 2P + \frac{5}{3} P} \approx 0.3 \, \text{dB}.$$

Note that the power relation between the DPDCH and the DPCCH is not 3 dB in compressed mode since the frame format change is compensated in power. The increased power of the TPC bits may to some extent compensate for the loss of a few TFC commands.

The calculated power saving above of course becomes much smaller for high bit rate CCTrCHs (which have a larger power difference between the DPDCH and DPCCH). The gain for lower bit rate CCTrCHs is however significant and it is therefore proposed that in total six additional frame formats are included in the WG1 specifications.

3 Downlink compressed mode

Transmission gaps of 3, 4, 5, and 7 slots in a radio frame are currently supported in [2]. If the spreading factor is reduced by a factor of two, then the available transmission gap is 7.5 slots. This means that for all cases the obtained transmission gap is longer than necessary. No pilot and TPC commands are sent during the transmission gap and a loss in performance will therefore result. It is proposed that this loss is minimized by transmitting pilot and TPC commands in all slots that are not used for measurements. If for example only 5 slots are needed for measurements, pilot and TPC commands will be transmitted in 10 of the 15 slots.

No TFCI bits are transmitted in the 7 empty slots obtained by reducing the spreading factor. Further, half of the last TFCI field is filled with DTX bits. This DTX corresponds to the half slot obtained when reducing the spreading factor by two (7.5 - 7). An example of how the DTX would be placed is shown in Figure 3.

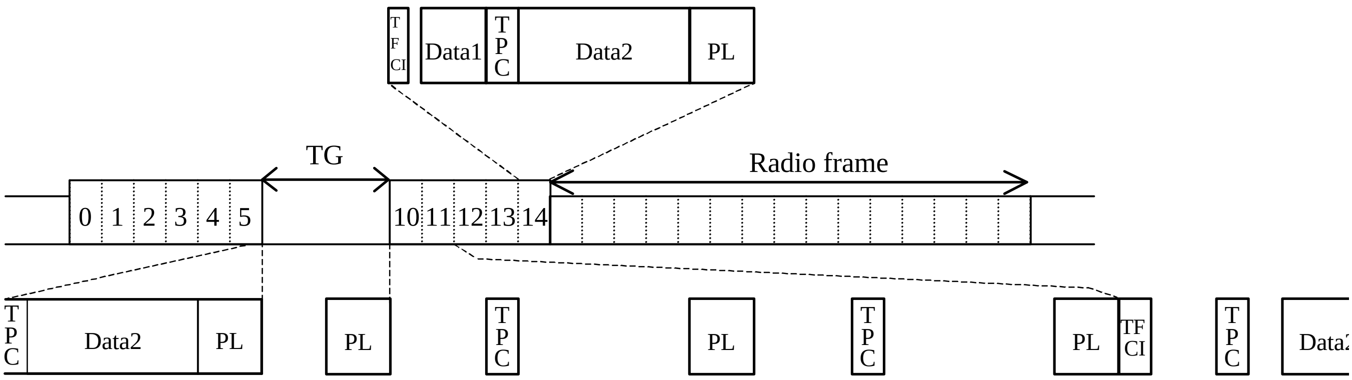


Figure 4: Example with TGL of 5 slots achieved through SF reduction

Note that in the above example there can also be DTX in slots 0-5 and 12-14.

4 Conclusion

A method and frame structure for compressed mode in uplink has been presented and missing details have been highlighted for downlink. It is proposed that the text proposal in Section 6 is included in [2].

5 References

[1] TSG RAN WG1, "TS 25.215 Physical layer - Measurements (FDD)".

[2] TSG RAN WG1, "TS 25.212 Multiplexing and channel coding (FDD)".

[3] Mitsubishi Electric, "Compressed mode function in multiplexing chain".

[4] Ericsson, "Use of multiple scrambling codes in compressed mode".

[5] TSG RAN WG1, “TS 25.211 Physical channels and mapping of transport channels onto physical channels (FDD)”.

6 Text proposal for 25.212

3.1 Definitions

For the purposes of the present document, the [following] terms and definitions [given in ... and the following] apply.

<defined term>: <definition>.

example: text used to clarify abstract rules by applying them literally.

TG Transmission Gap is consecutive empty slots that have been obtained with a transmission time reduction method. The transmission gap can be contained in one or two consecutive radio frames.

TGL Transmission Gap Length is the number of consecutive empty slots that have been obtained with a transmission time reduction method. $0 \leq TGL \leq 14$

3.2 Symbols

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

<symbol> <Explanation>

éxù round towards ¥, i.e. integer such that *x* £ *éxù* < *x*+1
ëxû round towards -¥, i.e. integer such that *x*-1 < *ëxû* £ *x*
çxç absolute value of *x*

N_{first} The first slot in the *TG*.
N_{last} The last slot in the *TG*. N_{last} is either a slot in the same radio frame as N_{first} or a slot in the radio frame immediately following the slot that contains N_{first}.

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

-- snip --

4.2 Transport-channel coding/multiplexing

-- snip --

4.2.7 Rate matching

<Editors’ note: Rate matching for Turbo codes is a working assumption.>

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

The number of bits on a transport channel can vary between different transmission time intervals. In the downlink the transmission is interrupted if the number of bits is lower than maximum. When the number of bits between different transmission time intervals in uplink is changed, bits are repeated or punctured to ensure that the total bit rate after second multiplexing is identical to the total channel bit rate of the allocated dedicated physical channels.

Notation used in Section 4.2.7 and subsections:

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

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

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

ΔN_{ij} : For uplink: If positive - number of bits that should be repeated in each radio frame on TrCH *i* with transport format combination *j*.

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

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

ΔN_{il}^{TTI} : If positive - number of bits to be repeated in each transmission time interval on TrCH *i* with transport format *j*.

If negative - number of bits to be punctured in each transmission time interval on TrCH *i* with transport format *j*. Used in downlink only.

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

PL: Puncturing limit for uplink. This value limits the amount of puncturing that can be applied in order to avoid multicode or to enable the use of a higher spreading factor. Signalled from higher layers.

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

I: Number of TrCHs in the CCTrCH.

Z_{ij}: Intermediate calculation variable.

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

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

q: Average puncturing distance. Used in uplink only.

$I_F(n_i)$: The inverse interleaving function of the 1st interleaver (note that the inverse interleaving function is identical to the interleaving function itself for the 1st interleaver). Used in uplink only.

$S(n_i)$: The shift of the puncturing pattern for radio frame n_i. Used in uplink only.

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

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

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

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

X: Systematic bit in section 4.2.3.2.1.

Y: 1st parity bit (from the upper Turbo constituent encoder) in section 4.2.3.2.1.

Y': 2nd parity bit (from the lower Turbo constituent encoder) in section 4.2.3.2.1.

Note: Time index t in section 4.2.3.2.1 is omitted for simplify the rate matching description.

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

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

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

$$Z_{ij} = \left\lfloor \frac{\sum_{m=1}^{i} RM_m \cdot N_{mj}}{\sum_{m=1}^{I} RM_m \cdot N_{mj}} \cdot N_{data,j} \right\rfloor$$ for all *i* = 1 .. *I*~~, where ë û means round downwards~~ **Equation 1**

$$\Delta N_{ij} = Z_{ij} - Z_{i-1,j} - N_{ij}$$ for all *i* = 1 .. *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 used to avoid multicode or to enable the use of a higher spreading factor when this is needed because the UE does not support SF down to 4. The maximum amount of puncturing that can be applied is signalled from higher layers and denoted by *PL*. The number of available bits in the radio frames 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 values of N_{data} then are $\{ N_{256}, N_{128}, N_{64}, N_{32}, N_{16}, N_8, N_4, 2N_4, 3N_4, 4N_4, 5N_4, 6N_4\}$.Depending on the UE capabilities, the supported set of N_{data} , denoted SET0, can be a subset of $\{ N_{256}, N_{128}, N_{64}, N_{32}, N_{16}, N_8, N_4, 2N_4, 3N_4, 4N_4, 5N_4, 6N_4\}$. $N_{data,j}$ for the transport format combination j is determined by executing the following algorithm:

SET1 = { N_{data} in SET0 such that $N_{data} - \sum_{x=1}^{I} \frac{RM_{x,}}{\min_{1\le y\le I}\{RM_y\}} \cdot N_{x,j}$ is non negative }

If the smallest element of SET1 requires just one PhCH then

$N_{data,j}$ = min SET1

else

SET2 = { N_{data} in SET0 such that $N_{data} - PL \cdot \sum_{x=1}^{I} \frac{RM_x}{\min_{1\le y\le I}\{RM_y\}} \cdot N_{x,j}$ 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

4.2.7.1.2 Determination of parameters needed for calculating the rate matching pattern

The number of bits to be repeated or punctured, DN_{ij}, within one radio frame for each TrCH *i* is calculated with Equation 1 ~~the relations given in Section 4.2.7~~ for all possible transport format combinations *j* and selected every radio frame. $N_{data,j}$ is given from section 4.2.7.1.1. In compressed mode $N_{data,j}$ is replaced by $N_{data,j}^{cm}$ in Equation 1. $N_{data,j}^{cm}$ is given from the following relation:

$N_{data,j}^{cm} = 2N_{data,j} - N_{TGL}$, where

$$N_{TGL} = \begin{cases} \frac{TGL}{15} 2N_{data,j}, & \text{if } N_{first} + TGL \le 15 \\ \frac{15 - N_{first}}{15} 2N_{data,j}, & \text{in first frame if } N_{first} + TGL > 15 \\ \frac{TGL - (15 - N_{first})}{15} 2N_{data,j}, & \text{in second frame if } N_{first} + TGL > 15 \end{cases}$$

N_{first} and *TGL* are defined in Section 4.4.

Additionally, for determining e_{ini}, the following parameters are needed (regardless if the radio frame is compressed or not):

-- snip --

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 $v_{p1}, v_{p2}, \dots, v_{pU}$, where *p* is the PhCH number and *U* is the number of bits in one radio frame for one PhCH. The bits v_{pk} are mapped to the PhCHs so that the bits for each PhCH are transmitted over the air in ascending order with respect to *k*.

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 Section 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. Bits $v_{pk} \notin \{0, 1\}$ are not transmitted.

In compressed mode obtained with transmission time reduction method B, the following PhCH mapping rule should be used:

- If $N_{first} + TGL \le 15$, there are two cases

```
if N_first + 8 ≤ 14
   no bits are mapped to slots N_first, N_first + 1, N_first + 2, …, N_last + (7 - TGL)
   no bits are mapped to the first half of the data fields of slot N_last + (8 - TGL)
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, …, N_first - (7 - TGL - (14 - N_last))
   no bits are mapped to the second half of the data fields of slot N_first - (8 - TGL - (14 - N_last))
end if
```

- If $N_{first} + TGL > 15$ then in the first radio frame, no bits are mapped to the second half of the data fields in slot 7 and no bits are mapped to the slots 8, 9, 10, ..., 14.

- If $N_{first} + TGL > 15$, then in the second radio frame, no bits are mapped to the slots 0, 1, 2, ..., 6 and no bits are mapped to the first half of the data fields in slot 7.

The following rules should be used for the selection of fixed or flexible positions of the TrCHs in the radio frame:

- For TrCHs not relying on TFCI for transport format detection (blind transport format detection), the positions of the transport channels within the radio frame should be fixed. In a limited number of cases, where there are a small number of transport format combinations, it is possible to allow flexible positions.

- For TrCHs relying on TFCI for transport format detection, higher layer signal whether the positions of the transport channels should be fixed or flexible.

-- snip --

<Ericsson's note: Section 4.2.15 was moved without changes to section 4.3. It seems strange to describe transport format detection in two different sections.>

~~4.2.15 Transport format detection~~

~~Transport format detection can be performed both with and without Tansport Format Combination Indicator (TFCI). If a TFCI is transmitted, the receiver detects the transport format combination from the TFCI. When no TFCI is transmitted, so~~

~~called blind transport format detection is used, i.e. the receiver side detects the transport format combination using some information, e.g. received power ratio of DPDCH to DPCCH, CRC check results.~~

~~For uplink, the blind transport format detection is an operator option. For downlink, the blind transport format detection can be applied with convolutional coding, the maximum number of different transport formats and maximum data rates allowed shall be specified.~~

~~4.2.15.1Blind transport format detection~~

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

~~4.2.15.2Explicit transport format detection based on TFCI~~

~~4.2.15.2.1Transport format combination indicator (TFCI)~~

~~The Transport Format Combination Indicator (TFCI) informs the receiver of the transport format combination of the CCTrCHs. As soon as the TFCI is detected, the transport format combination, and hence the individual transport channels' transport formats are known, and decoding of the transport channels can be performed.~~

~~4.2.16~~4.2.15 ~~Coding procedure~~ System Frame Number (SFN)

~~4.2.15.1SFN(System Frame Number)~~

- SFN indicates super frame synchronisation. It is broadcasted in BCH. (See TS 25.211)

<Editor's note: Length of SFN is FFS. It will be determined according to requirement from WG2and WG3>

- SFN is multiplexed with a BCH transport block (see Figure 9).
- SFN is applied CRC calculation and FEC with BCH transport block.

MSB LSB	MSB LSB
SFN	BCH transport block

Figure 9: SFN multiplexing

4.3 ~~Coding for layer 1 control~~ Transport format detection

Transport format detection can be performed both with and without Tansport Format Combination Indicator (TFCI). If a TFCI is transmitted, the receiver detects the transport format combination from the TFCI. When no TFCI is transmitted, so called blind transport format detection is used, i.e. the receiver side detects the transport format combination using some information, e.g. received power ratio of DPDCH to DPCCH, CRC check results.

For uplink, the blind transport format detection is an operator option. For downlink, the blind transport format detection can be applied with convolutional coding, the maximum number of different transport formats and maximum data rates allowed shall be specified.

4.3.1 Blind transport format detection

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

4.3.2 Explicit transport format detection based on TFCI

The Transport Format Combination Indicator (TFCI) informs the receiver of the transport format combination of the CCTrCHs. As soon as the TFCI is detected, the transport format combination, and hence the individual transport channels' transport formats are known, and decoding of the transport channels can be performed.

~~4.3.1~~4.3.3 Coding of Transport-format-combination indicator (TFCI)

The number of TFCI bits is variable and is set at the beginning of the call via higher layer signalling. For improved TFCI detection reliability, in downlink, repetition is used by increasing the number of TFCI bits within a slot.

The TFCI bits are encoded using (30, 10) punctured sub-code of the second order Reed-Muller code. The coding procedure is as shown in Figure 10.

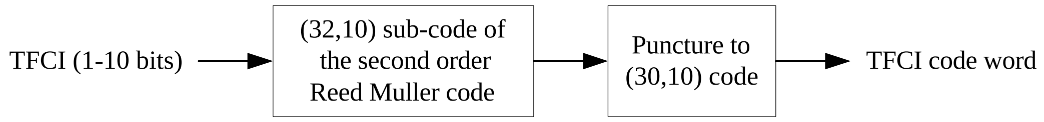


Figure 10: Channel coding of TFCI bits

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 receiver can use the information that not all 10 bits are used for the TFCI, thereby reducing the error rate in the TFCI decoder. The length of the TFCI code word is 30 bits. Thus there are 2 bits of (encoded) TFCI in every slot of the radio frame.

Firstly, TFCI is encoded by the (32,10) sub-code of second order Reed-Muller code. The code words of the (32,10) sub-code of second order Reed-Muller code are linear combination of 10 basis sequences: all 1's, 5 OVSF codes ($C_{32,1}$, $C_{32,2}$, $C_{32,4}$, $C_{32,8}$, $C_{32,16}$), and 4 masks (Mask1, Mask2, Mask3, Mask4). The 4 mask sequences are as following Table 7.

Table 7: Mask sequences

Mask 1	00101000011000111111000001110111
Mask 2	00000001110011010110110111000111
Mask 3	00001010111110010001101100101011
Mask 4	00011100001101110010111101010001

For information bits a_0, a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9 (a_0 is LSB and a_9 is MSB), the encoder structure is as following Figure 11.

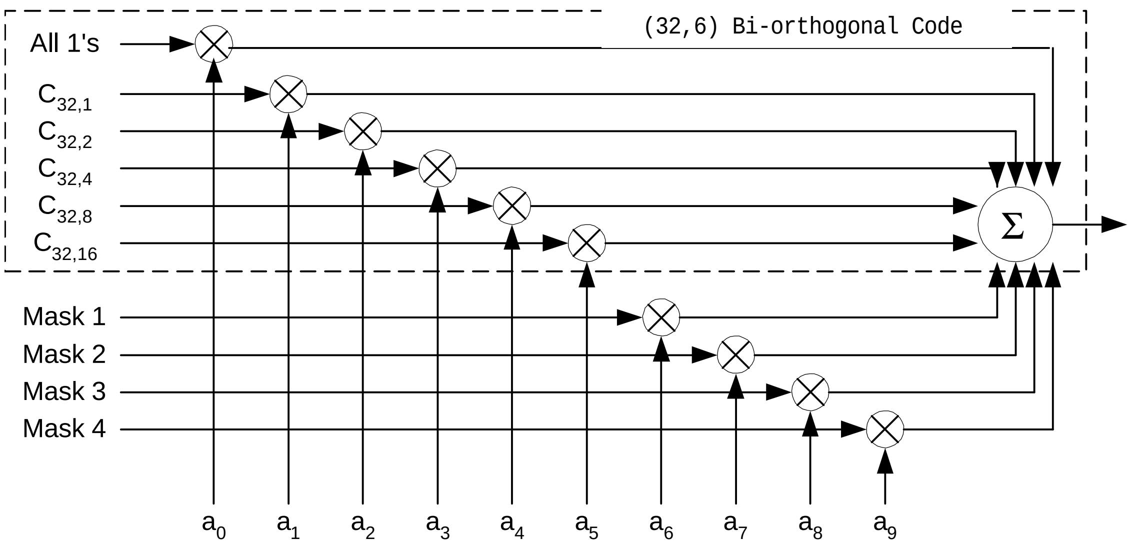


Figure 11: Encoder structure for (32,10) sub-code of second order Reed-Muller code

<Ericsson's note: It is not clear if the first bit corresponds to the "LSB or the MSB". In general it does not make sense to talk about MSB and LSB for a code word and it should be avoided. Removing MSB and LSB do however require changes in several sections.>

Then, the code words of the (32,10) sub-code of second order Reed-Muller code are punctured into length 30 by puncturing 1st and 17th bits. The remaining bits are denoted by b_k, k = 0, 1, 2, …, 29 (k = 29 corresponds to the MSB bit).

In downlink, when the SF is lower then 128 the encoded and punctured TFCI code words are repeated four times yielding 8 encoded TFCI bits per slot. Mapping of repeated bits to slots is explained in section 4.3.5~~3~~.

~~4.2.2~~4.3.4 Operation of Transport-format-combination indicator (TFCI) in Split Mode

In the case of DCH in Split Mode, the UTRAN shall operate with as follows:

- If one of the links 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.

TFCI information is encoded by biorthogonal (16, 5) block code. The code words of the biorthogonal (16, 5) code are from two mutually biorthogonal sets, $S_{C_{16}} = \{C_{16,0}, C_{16,1}, ..., C_{16,15}\}$ and its binary complement, $\overline{S}_{C_{16}} = \{\overline{C}_{16,0}, \overline{C}_{16,1}, ..., \overline{C}_{16,15}\}$. Code words of set $S_{C_{16}}$ are from the level 16 of the code three of OVSF codes defined in document TS 25.213. The mapping of information bits to code words is shown in the Table 8.

Table 8: Mapping of information bits to code words for biorthogonal (16, 5) code

Information bits	Code word
00000	$C_{16,0}$
00001	$\overline{C}_{16,0}$
00010	$C_{16,1}$
...	...
11101	$\overline{C}_{16,14}$
11110	$C_{16,15}$
11111	$\overline{C}_{16,15}$

Biorthogonal code words, $C_{16,i}$ and $\overline{C}_{16,i}$, are then punctured into length 15 by puncturing the 1st bit. The bits in the code words are denoted by $b_{j,k}$, where subscript *j* indicates the code word and subscript *k* indicates bit position in the code word (*k* =14 corresponds to the MSB bit).

~~4.2.3~~4.3.5 Mapping of TFCI words

~~4.3.3.1~~4.3.5.1 Mapping of TFCI word

As only one code word for TFCI is needed no channel interleaving for the encoded bits are done. Instead, the bits of the code word are directly mapped to the slots of the radio frame as depicted in the Figure 12. Within a slot the more significant bit is transmitted before the less significant bit.

<Ericsson's note: The compressed mode figures were moved to a separate section.>

~~In compressed mode all the TFCI bits are reallocated into the remaining slots. However, the same principle of transmitting the most significant bit first is valid.~~

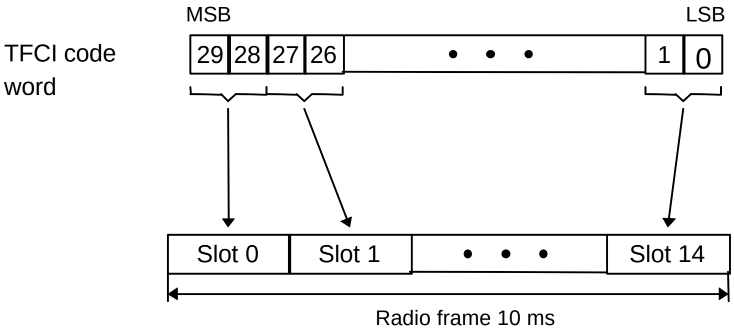
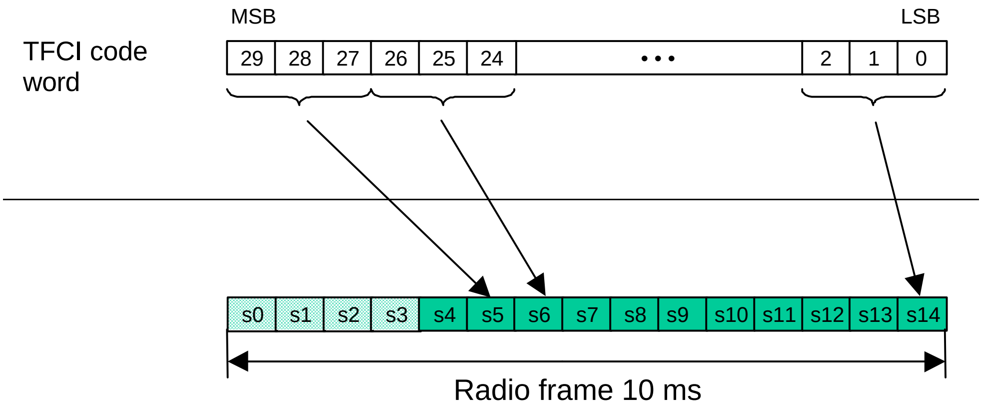
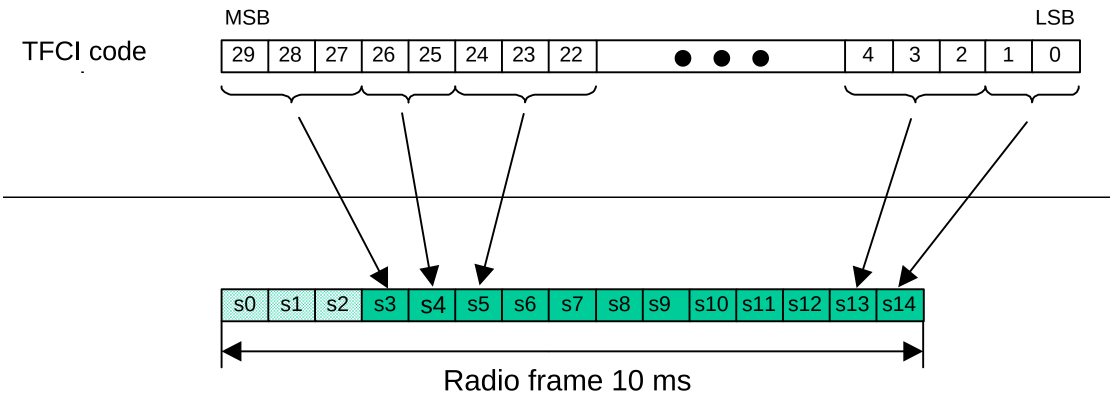


Figure 12: Mapping of TFCI code words to the slots of the radio frame



~~**Figure 13: Mapping of TFCI code words to the slots of a compressed radio frame of 11 slots.**~~



~~**Figure 14: Mapping of TFCI code words to the slots of a compressed radio frame of 12 slots.**~~

<Ericsson's note: The notation was changed to align with the first part of Section 4.3.5.2 (Figure 15). The alternative would have been to align the second part of Section 4.3.5.2 with the first part but since different subscripts usually indicate different bits, the notation in this section was modified.>

For downlink physical channels whose SF is lower than 128, bits of the TFCI code words are repeated and mapped to slots as shown in the Table 9. Code word bits are denoted as b_k^l ~~$b_{i,j}$~~, where subscript k~~i~~, indicates bit position in the code word (k ~~i~~= 29 is the MSB bit) and super~~b~~script l~~j~~ indicates bit repetition. In each slot transmission order of the bits is from left to right in the Table 9.

Table 9: Mapping order of repetition encoded TFCI code word bits into slots.

Slot	TFCI code word bits							
0	b_{29}^1	b_{29}^2	b_{29}^3	b_{29}^4	b_{28}^1	b_{28}^2	b_{28}^3	b_{28}^4
1	b_{27}^1	b_{27}^2	b_{27}^3	b_{27}^4	b_{26}^1	b_{26}^2	b_{26}^3	b_{26}^4
2	b_{25}^1	b_{25}^2	b_{25}^3	b_{25}^4	b_{24}^1	b_{24}^2	b_{24}^3	b_{24}^4
3	b_{23}^1	b_{23}^2	b_{23}^3	b_{23}^4	b_{22}^1	b_{22}^2	b_{22}^3	b_{22}^4
4	b_{21}^1	b_{21}^2	b_{21}^3	b_{21}^4	b_{20}^1	b_{20}^2	b_{20}^3	b_{20}^4
5	b_{19}^1	b_{19}^2	b_{19}^3	b_{19}^4	b_{18}^1	b_{18}^2	b_{18}^3	b_{18}^4
6	b_{17}^1	b_{17}^2	b_{17}^3	b_{17}^4	b_{16}^1	b_{16}^2	b_{16}^3	b_{16}^4
7	b_{15}^1	b_{15}^2	b_{15}^3	b_{15}^4	b_{14}^1	b_{14}^2	b_{14}^3	b_{14}^4
8	b_{13}^1	b_{13}^2	b_{13}^3	b_{13}^4	b_{12}^1	b_{12}^2	b_{12}^3	b_{12}^4
9	b_{11}^1	b_{11}^2	b_{11}^3	b_{11}^4	b_{10}^1	b_{10}^2	b_{10}^3	b_{10}^4
10	b_{9}^1	b_{9}^2	b_{9}^3	b_{9}^4	b_{8}^1	b_{8}^2	b_{8}^3	b_{8}^4
11	b_{7}^1	b_{7}^2	b_{7}^3	b_{7}^4	b_{6}^1	b_{6}^2	b_{6}^3	b_{6}^4
12	b_{5}^1	b_{5}^2	b_{5}^3	b_{5}^4	b_{4}^1	b_{4}^2	b_{4}^3	b_{4}^4
13	b_{3}^1	b_{3}^2	b_{3}^3	b_{3}^4	b_{2}^1	b_{2}^2	b_{2}^3	b_{2}^4
14	b_{1}^1	b_{1}^2	b_{1}^3	b_{1}^4	b_{0}^1	b_{0}^2	b_{0}^3	b_{0}^4

~~**Table 9: Mapping order of repetition encoded TFCI code word bits into slots.**~~

Slot	TFCI code word bits							
0	$b_{29,1}$	$b_{29,2}$	$b_{29,3}$	$b_{29,4}$	$b_{28,1}$	$b_{28,2}$	$b_{28,3}$	$b_{28,4}$
1	$b_{27,1}$	$b_{27,2}$	$b_{27,3}$	$b_{27,4}$	$b_{26,1}$	$b_{26,2}$	$b_{26,3}$	$b_{26,4}$
2	$b_{25,1}$	$b_{25,2}$	$b_{25,3}$	$b_{25,4}$	$b_{24,1}$	$b_{24,2}$	$b_{24,3}$	$b_{24,4}$
3	$b_{23,1}$	$b_{23,2}$	$b_{23,3}$	$b_{23,4}$	$b_{22,1}$	$b_{22,2}$	$b_{22,3}$	$b_{22,4}$
4	$b_{21,1}$	$b_{21,2}$	$b_{21,3}$	$b_{21,4}$	$b_{20,1}$	$b_{20,2}$	$b_{20,3}$	$b_{20,4}$
5	$b_{19,1}$	$b_{19,2}$	$b_{19,3}$	$b_{19,4}$	$b_{18,1}$	$b_{18,2}$	$b_{18,3}$	$b_{18,4}$
6	$b_{17,1}$	$b_{17,2}$	$b_{17,3}$	$b_{17,4}$	$b_{16,1}$	$b_{16,2}$	$b_{16,3}$	$b_{16,4}$
7	$b_{15,1}$	$b_{15,2}$	$b_{15,3}$	$b_{15,4}$	$b_{14,1}$	$b_{14,2}$	$b_{14,3}$	$b_{14,4}$
8	$b_{13,1}$	$b_{13,2}$	$b_{13,3}$	$b_{13,4}$	$b_{12,1}$	$b_{12,2}$	$b_{12,3}$	$b_{12,4}$
9	$b_{11,1}$	$b_{11,2}$	$b_{11,3}$	$b_{11,4}$	$b_{10,1}$	$b_{10,2}$	$b_{10,3}$	$b_{10,4}$
10	$b_{9,1}$	$b_{9,2}$	$b_{9,3}$	$b_{9,4}$	$b_{8,1}$	$b_{8,2}$	$b_{8,3}$	$b_{8,4}$
11	$b_{7,1}$	$b_{7,2}$	$b_{7,3}$	$b_{7,4}$	$b_{6,1}$	$b_{6,2}$	$b_{6,3}$	$b_{6,4}$
12	$b_{5,1}$	$b_{5,2}$	$b_{5,3}$	$b_{5,4}$	$b_{4,1}$	$b_{4,2}$	$b_{4,3}$	$b_{4,4}$
13	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	$b_{3,4}$	$b_{2,1}$	$b_{2,2}$	$b_{2,3}$	$b_{2,4}$
14	$b_{1,1}$	$b_{1,2}$	$b_{1,3}$	$b_{1,4}$	$b_{0,1}$	$b_{0,2}$	$b_{0,3}$	$b_{0,4}$

4.3.5.2 ~~4.3.3.2~~ Mapping of TFCI word in split mode

After channel encoding of the two 5 bit TFCI words there are two code words of length 15 bits. They are mapped to DPCCH as shown in the Figure 15. Note that ~~$b_{1,i}$~~ $b_{1,k}$ and ~~$b_{2,i}$~~ $b_{2,k}$ denote the bit ~~i~~k of code word 1 and code word 2, respectively.

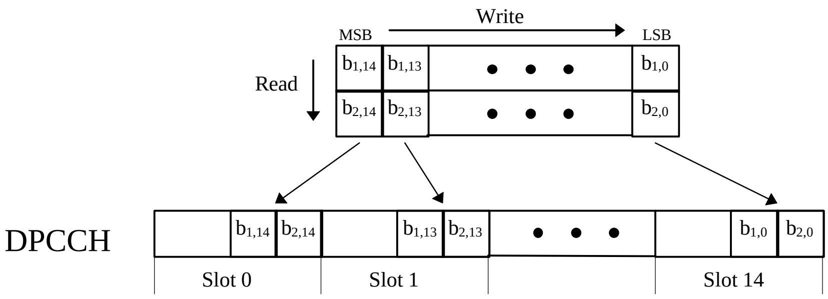


Figure 15: Mapping of TFCI code words to the slots of the radio frame in Split Mode

<Ericsson's note: The mapping in compressed mode is described in a separate section.>

~~In compressed mode the mapping of TFCI bits takes place in a similar fashion as for (30,10) word in section 4.3.3.1. The order of bits is $b_{1,15}$,$b_{2,15}$,$b_{1,14}$,$b_{2,14}$,…$b_{1,0}$,$b_{2,0}$.~~

For downlink physical channels whose SF is lower than 128, bits of the extended TFCI code words are repeated and mapped to slots as shown in the Table 10. Code word bits are denoted as ~~$b^{k}_{i,j}$~~ $b^{l}_{j,k}$, where subscript j~~k~~ indicates the code word, subscript k~~i~~ indicates bit position in the code word (~~i~~k =14 is the MSB bit) and super~~b~~script l~~j~~ indicates bit repetition. In each slot transmission order of the bits is from left to right in the Table 10.

Table 10: Mapping order of repetition encoded TFCI code word bits to slots in Split Mode

Slot	TFCI code word bits in split mode							
0	$b^{1}_{1,14}$	$b^{2}_{1,14}$	$b^{3}_{1,14}$	$b^{4}_{1,14}$	$b^{1}_{2,14}$	$b^{2}_{2,14}$	$b^{3}_{2,14}$	$b^{4}_{2,14}$
1	$b^{1}_{1,13}$	$b^{2}_{1,13}$	$b^{3}_{1,13}$	$b^{4}_{1,13}$	$b^{1}_{2,13}$	$b^{2}_{2,13}$	$b^{3}_{2,13}$	$b^{4}_{2,13}$
2	$b^{1}_{1,12}$	$b^{2}_{1,12}$	$b^{3}_{1,12}$	$b^{4}_{1,12}$	$b^{1}_{2,12}$	$b^{2}_{2,12}$	$b^{3}_{2,12}$	$b^{4}_{2,12}$
3	$b^{1}_{1,11}$	$b^{2}_{1,11}$	$b^{3}_{1,11}$	$b^{4}_{1,11}$	$b^{1}_{2,11}$	$b^{2}_{2,11}$	$b^{3}_{2,11}$	$b^{4}_{2,11}$
4	$b^{1}_{1,10}$	$b^{2}_{1,10}$	$b^{3}_{1,10}$	$b^{4}_{1,10}$	$b^{1}_{2,10}$	$b^{2}_{2,10}$	$b^{3}_{2,10}$	$b^{4}_{2,10}$
5	$b^{1}_{1,9}$	$b^{2}_{1,9}$	$b^{3}_{1,9}$	$b^{4}_{1,9}$	$b^{1}_{2,9}$	$b^{2}_{2,9}$	$b^{3}_{2,9}$	$b^{4}_{2,9}$
6	$b^{1}_{1,8}$	$b^{2}_{1,8}$	$b^{3}_{1,8}$	$b^{4}_{1,8}$	$b^{1}_{2,8}$	$b^{2}_{2,8}$	$b^{3}_{2,8}$	$b^{4}_{2,8}$
7	$b^{1}_{1,7}$	$b^{2}_{1,7}$	$b^{3}_{1,7}$	$b^{4}_{1,7}$	$b^{1}_{2,7}$	$b^{2}_{2,7}$	$b^{3}_{2,7}$	$b^{4}_{2,7}$
8	$b^{1}_{1,6}$	$b^{2}_{1,6}$	$b^{3}_{1,6}$	$b^{4}_{1,6}$	$b^{1}_{2,6}$	$b^{2}_{2,6}$	$b^{3}_{2,6}$	$b^{4}_{2,6}$
9	$b^{1}_{1,5}$	$b^{2}_{1,5}$	$b^{3}_{1,5}$	$b^{4}_{1,5}$	$b^{1}_{2,5}$	$b^{2}_{2,5}$	$b^{3}_{2,5}$	$b^{4}_{2,5}$
10	$b^{1}_{1,4}$	$b^{2}_{1,4}$	$b^{3}_{1,4}$	$^{4}_{1,}$	$b^{1}_{2\ 4}$	$b_{,4}$	$b^{3}_{2,4}$	$b^{4}_{2,4}$
11	$b^{1}_{1,3}$	$b^{2}_{1,3}$	$b^{3}_{1,3}$	$b^{4}_{1,3}$	$b^{1}_{2,3}$	$b^{2}_{2,3}$	$b^{3}_{2,3}$	$b^{4}_{2,3}$
12	$b^{1}_{1,2}$	$b^{2}_{1,2}$	$b^{3}_{1,2}$	$b^{4}_{1,2}$	$b^{1}_{2,2}$	$b^{2}_{2,2}$	$b^{3}_{2,2}$	$b^{4}_{2,2}$
13	$b^{1}_{1,1}$	$b^{2}_{1,1}$	$b^{3}_{1,1}$	$b^{4}_{1,1}$	$b^{1}_{2,1}$	$b^{2}_{2,1}$	$b^{3}_{2,1}$	$b^{4}_{2,1}$
14	$b^{1}_{1,0}$	$b^{2}_{1,0}$	$b^{3}_{1,0}$	$b^{4}_{1,0}$	$b^{1}_{2,0}$	$b^{2}_{2,0}$	$b^{3}_{2,0}$	$b^{4}_{2,0}$

~~Slot~~	~~TFCI code word bits in split mode~~							
~~0~~	~~$b^{1}_{14,1}$~~	~~$b^{1}_{14,2}$~~	~~$b^{1}_{14,3}$~~	~~$b^{1}_{14,4}$~~	~~$b^{2}_{14,1}$~~	~~$b^{2}_{14,2}$~~	~~$b^{2}_{14,3}$~~	~~$b^{2}_{14,4}$~~
~~1~~	~~$b^{1}_{13,1}$~~	~~$b^{1}_{13,2}$~~	~~$b^{1}_{13,3}$~~	~~$b^{1}_{13,4}$~~	~~$b^{2}_{13,1}$~~	~~$b^{2}_{13,2}$~~	~~$b^{2}_{13,3}$~~	~~$b^{2}_{13,4}$~~
~~2~~	~~$b^{1}_{12,1}$~~	~~$b^{1}_{12,2}$~~	~~$b^{1}_{12,3}$~~	~~$b^{1}_{12,4}$~~	~~$b^{2}_{12,1}$~~	~~$b^{2}_{12,2}$~~	~~$b^{2}_{12,3}$~~	~~$b^{2}_{12,4}$~~

~~3~~	~~$b^{1}_{11,1}$~~	~~$b^{1}_{11,2}$~~	~~$b^{1}_{11,3}$~~	~~$b^{1}_{11,4}$~~	~~$b^{2}_{11,1}$~~	~~$b^{2}_{11,2}$~~	~~$b^{2}_{11,3}$~~	~~$b^{2}_{11,4}$~~
~~4~~	~~$b^{1}_{10,1}$~~	~~$b^{1}_{10,2}$~~	~~$b^{1}_{10,3}$~~	~~$b^{1}_{10,4}$~~	~~$b^{2}_{10,1}$~~	~~$b^{2}_{10,2}$~~	~~$b^{2}_{10,3}$~~	~~$b^{2}_{10,4}$~~
~~5~~	~~$b^{1}_{9,1}$~~	~~$b^{1}_{9,2}$~~	~~$b^{1}_{9,3}$~~	~~$b^{1}_{9,4}$~~	~~$b^{2}_{9,1}$~~	~~$b^{2}_{9,2}$~~	~~$b^{2}_{9,3}$~~	~~$b^{2}_{9,4}$~~
~~6~~	~~$b^{1}_{8,1}$~~	~~$b^{1}_{8,2}$~~	~~$b^{1}_{8,3}$~~	~~$b^{1}_{8,4}$~~	~~$b^{2}_{8,1}$~~	~~$b^{2}_{8,2}$~~	~~$b^{2}_{8,3}$~~	~~$b^{2}_{8,4}$~~
~~7~~	~~$b^{1}_{7,1}$~~	~~$b^{1}_{7,2}$~~	~~$b^{1}_{7,3}$~~	~~$b^{1}_{7,4}$~~	~~$b^{2}_{7,1}$~~	~~$b^{2}_{7,2}$~~	~~$b^{2}_{7,3}$~~	~~$b^{2}_{7,4}$~~
~~8~~	~~$b^{1}_{6,1}$~~	~~$b^{1}_{6,2}$~~	~~$b^{1}_{6,3}$~~	~~$b^{1}_{6,4}$~~	~~$b^{2}_{6,1}$~~	~~$b^{2}_{6,2}$~~	~~$b^{2}_{6,3}$~~	~~$b^{2}_{6,4}$~~
~~9~~	~~$b^{1}_{5,1}$~~	~~$b^{1}_{5,2}$~~	~~$b^{1}_{5,3}$~~	~~$b^{1}_{5,4}$~~	~~$b^{2}_{5,1}$~~	~~$b^{2}_{5,2}$~~	~~$b^{2}_{5,3}$~~	~~$b^{2}_{5,4}$~~
~~10~~	~~$b^{1}_{4,1}$~~	~~$b^{1}_{4,2}$~~	~~$b^{1}_{4,3}$~~	~~$b^{1}_{4,4}$~~	~~$b^{2}_{4,1}$~~	~~$b^{2}_{4,2}$~~	~~$b^{2}_{4,3}$~~	~~$b^{2}_{4,4}$~~
~~11~~	~~$b^{1}_{3,1}$~~	~~$b^{1}_{3,2}$~~	~~$b^{1}_{3,3}$~~	~~$b^{1}_{3,4}$~~	~~$b^{2}_{3,1}$~~	~~$b^{2}_{3,2}$~~	~~$b^{2}_{3,3}$~~	~~$b^{2}_{3,4}$~~
~~12~~	~~$b^{1}_{2,1}$~~	~~$b^{1}_{2,2}$~~	~~$b^{1}_{2,3}$~~	~~$b^{1}_{2,4}$~~	~~$b^{2}_{2,1}$~~	~~$b^{2}_{2,2}$~~	~~$b^{2}_{2,3}$~~	~~$b^{2}_{2,4}$~~
~~13~~	~~$b^{1}_{1,1}$~~	~~$b^{1}_{1,2}$~~	~~$b^{1}_{1,3}$~~	~~$b^{1}_{1,4}$~~	~~$b^{2}_{1,1}$~~	~~$b^{2}_{1,2}$~~	~~$b^{2}_{1,3}$~~	~~$b^{2}_{1,4}$~~
~~14~~	~~$b^{1}_{0,1}$~~	~~$b^{1}_{0,2}$~~	~~$b^{1}_{0,3}$~~	~~$b^{1}_{0,4}$~~	~~$b^{2}_{0,1}$~~	~~$b^{2}_{0,2}$~~	~~$b^{2}_{0,3}$~~	~~$b^{2}_{0,4}$~~

4.3.5.3 Mapping of TFCI in compressed mode

The mapping of the TFCI bits in compressed mode is dependent on the transmission time reduction method. Denote the TFCI bits by $c_0, c_1, c_2, c_3, c_4, \ldots, c_C$, where:

- $c_k = b_k$, $C = 29$, when there are 2 TFCI bit in each slot.
- $c_0 = b^4_0, c_1 = b^3_0, c_2 = b^2_0, c_3 = b^1_0, c_4 = b^4_1, c_5 = b^3_1, \ldots, c_{119} = b^1_{14}$, when there are 8 TFCI bits in each slot.
- $c_0 = b_{2,0}, c_1 = b_{1,0}, c_3 = b_{2,1}, c_4 = b_{1,1}, \ldots, c_{29} = b_{1,14}$, in split mode when there are 2 TFCI bits in each slot.
- $c_0 = b^4_{2,0}, c_1 = b^3_{2,0}, c_2 = b^2_{2,0}, c_3 = b^1_{2,0}, c_4 = b^4_{1,0}, c_5 = b^3_{1,0}, \ldots, c_{119} = b^1_{1,14}$, in split mode when there are 8 TFCI bits in each slot.

The TFCI mapping for each transmission method is given in the sections below.

4.3.5.3.1 Compressed mode method A

<Ericsson's note: Nothing new is proposed in Section 4.3.5.3.1 and subsections. The section is a generalisation of the old Figure 13 and 14. The old figures did not define the 8 TFCI bits/slot case.>

For compressed mode by method A, all the TFCI bits are mapped to the remaining slots. The number of bits per slot in uncompressed mode is denoted by Z and $Z = (C + 1)/15$. The mapping to slots for different TGLs are defined below.

4.3.5.3.1.1 TGL of 3 slots

Slot number 3 + 2x contain bits $c_{C-(\frac{5}{2}Z)x}, c_{C-(\frac{5}{2}Z)x-1}, \ldots, c_{C-(\frac{5}{2}Z)x-(\frac{3}{2}Z-1)}$, where x = 0, 1, 2, 3, 4, 5

Slot number 4 + 2x contain bits $c_{C-\frac{3}{2}Z-(\frac{5}{2}Z)x}, c_{C-\frac{3}{2}Z-(\frac{5}{2}Z)x-1}, \ldots, c_{C-\frac{3}{2}Z-(\frac{5}{2}Z)x-(Z-1)}$, where x = 0, 1, 2, 3, 4, 5

The case when C = 29 is illustrated in Figure 13.

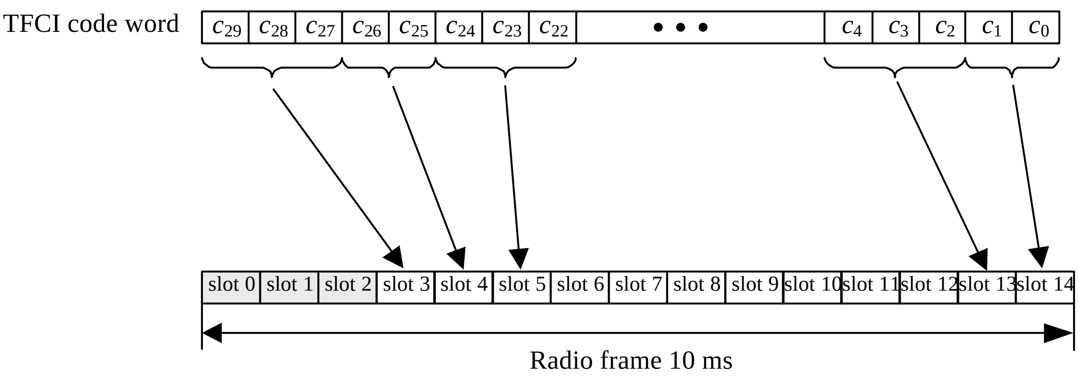


Figure 13: Mapping of TFCI code with TGL of 3 slots.

4.3.5.3.1.2 TGL of 4 slots

Slot number 4 does not contain any TFCI bits.

Slot number 5 + x contain bits $c_{C-(\frac{3}{2}Z)x}, c_{C-(\frac{3}{2}Z)x-1}, \ldots, c_{C-(\frac{3}{2}Z)x-(\frac{3}{2}Z-1)}$, where x = 0, 1, 2, 3, …, 9

The case when C = 29 is illustrated in Figure 14.

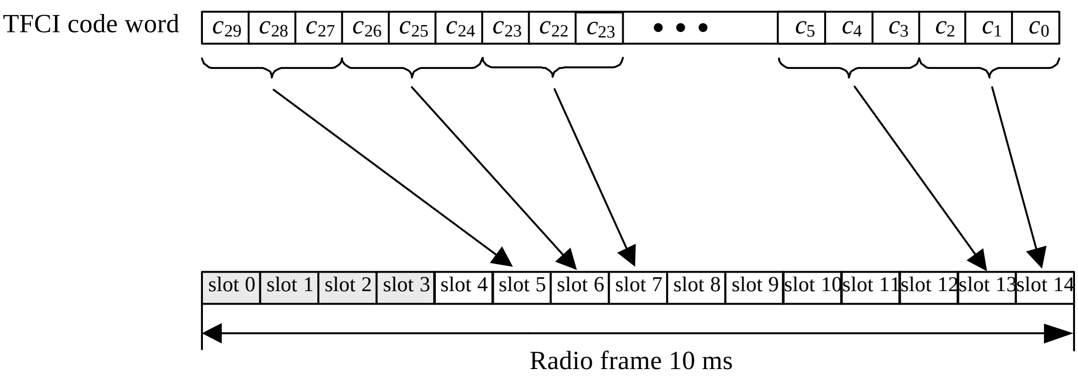


Figure 14: Mapping of TFCI code with TGL of 4 slots.

4.3.5.3.2 Compressed mode method B

4.3.5.3.2.1 Uplink

For uplink compressed mode by method B the frame format is changed so that no TFCI bits are lost. The different frame formats in compressed mode can not match the exact number of TFCI bits for all possible TGLs. Repetition of the TFCI bits is therefore used.

Denote the number of TFCI bits after coding by C, the number of bits available in the TFCI fields of one compressed radio frame by D, the repeated bits by d_k, and the number of bits in the TFCI field in a slot by N_{TFCI}. Let E=C-1-($N_{first}N_{TFCI}$)mod$C$. If N_{last}≠14, then E corresponds to the number of the first TFCI bit in the slot directly after the TG. The following relations then define the repetition.

$$d_{D-C-1} = c_{E \bmod C}, d_{D-C-2} = c_{(E-1) \bmod C}, d_{D-C-3} = c_{(E-2) \bmod C}, \ldots, d_0 = c_{(E-(D-C)) \bmod C}$$

The bits are mapped to the slots in descending order starting with the original bits and followed by the repeated ones, i.e. c_C is sent as first bit in the TFCI field of the first transmitted slot and d_0 as last bit in the TFCI field of the last transmitted slot.

4.3.5.3.2.2 Downlink

For downlink compressed mode by method B, TFCI bits are only mapped to the 8 slots that the DPDCH is transmitted in (defined in Section 4.2.12.2). The number of TFCI bits per slot in uncompressed mode is denoted by *Z* and $Z = (C + 1)/15$. The 8 slots with TFCI bits all contain 2*Z* bits in each TFCI field. DTX is used for the last Z bits in the last TFCI field containing TFCI bits.

The bits c_k are mapped to the slots in descending order.

4.4 C~~oding of c~~ompressed mode

In compressed mode, slots N_{first} to N_{last} are not used for transmission of data. As illustrated in Figure 16, which shows the example of fixed ~~idle length~~transmission gap position with single frame method (see section 0), 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 section 4.4.2). What frames are compressed, are decided by the network. When in compressed mode, compressed frames can occur periodically, as illustrated in Figure 16, or requested on demand. The rate and type of compressed frames is variable and depends on the environment and the measurement requirements.

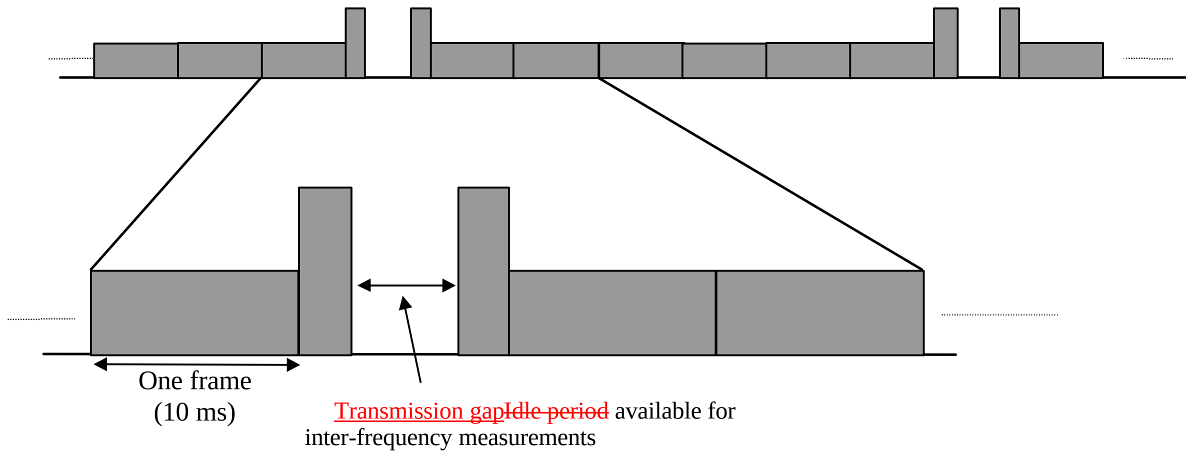


Figure 16: Compressed mode transmission

4.4.1 Frame structure in the uplink

The frame structure for uplink compressed mode is illustrated in Figure 17.

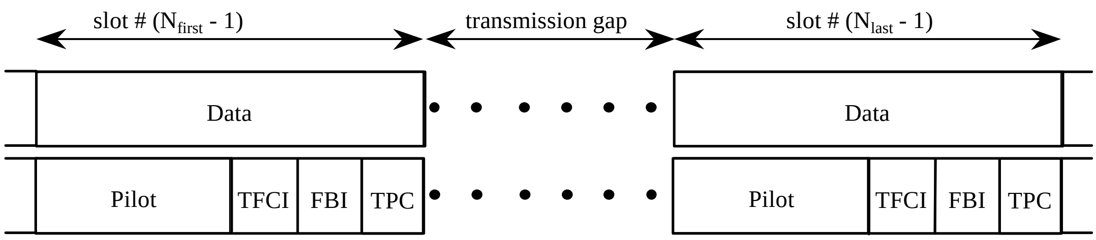
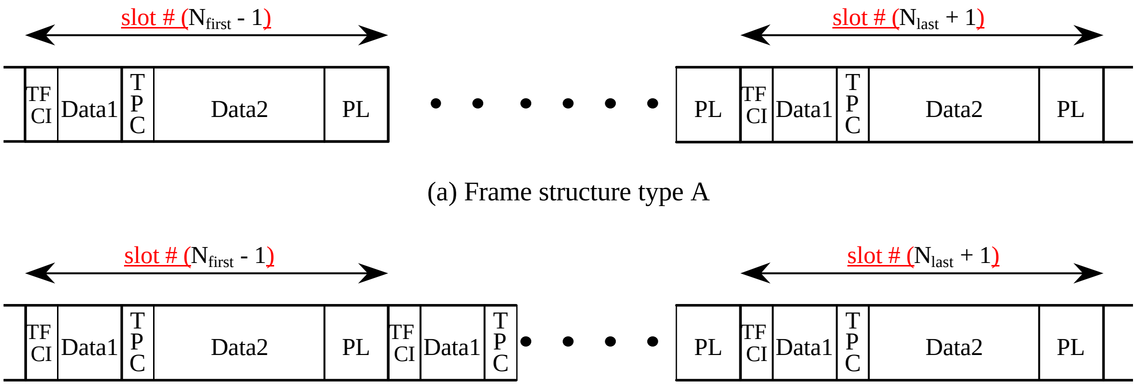


Figure 17: Frame structure in uplink compressed transmission

~~4.4.1~~4.4.2 Frame structure types in the downlink

There are two different types of frame structures defined for downlink compressed transmission. Type A is the basic case, which maximises the transmission gap length. Type B, which is more optimised for power control, can be used if the requirement of the transmission gap length allows that. ~~Slot structure for uplink compressed mode is for further study.~~

- With frame structure of type A, BTS transmission is off from the beginning of TFCI field in slot N_{first}, until the end of Data2 field in slot N_{last} (Figure ~~17~~18 (a)).
- With frame structure of type B, BTS transmission is off from the beginning of Data2 field in slot N_{first}, until the end of Data2 field in slot N_{last} (Figure ~~17~~18 (b)) Dummy bits are transmitted in the TFCI and Data1 fields of slot N_{first}, and BTS and MS do not use the dummy bits. Thus BTS and MS utilize only the TPC field of N_{first}.



(a) Frame structure type A

(b) Frame structure type B

Figure 1~~7~~8: Frame structure types in downlink compressed transmission

~~4.4.2~~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 mechanism provided for achieving this is either changing the code rate (method A), which means puncturing in practice, or the -reduction of the spreading factor by a factor of two (method B). In the downlink, both method A and B are supported while only method B is used in the uplink. The maximum idle length -is defined to be 5 ms -per one 10 ms frame.

~~4.4.2.1~~4.4.3.1 Method A1: By puncturing, basic case

During compressed mode, rate matching (puncturing) is applied for making short transmission gap length in one frame. Algorithm of rate matching (puncturing) described in Section 4.2.7 is used. The maximum transmission gap length allowed to be achieved with this method is the case where the code rate is increased from 1/3 to 1/2 by puncturing, depending on the rate matching conditions that would be used in the non-compressed frame case. The explanation of the rate matching conditions are given below:

Example 1: If rate matching conditions in the non-compressed frame case would be such that maximum puncturing =0.2 would be used, then during compressed mode further puncturing of 1-(2/(3*(1-0.2))) =0.17 is allowed which corresponds to 0.17*15=2.55 => 2 time slots.

Example 2: If rate matching conditions in the non-compressed frame case would be such that no puncturing would be used, then during compressed mode puncturing of 1-(2/3)=0.33 is allowed which corresponds to 0.33*15=4.95 => 4 time slots.

DPDCH and DPCCH fields for compressed mode when puncturing 4 slots and 3 slots, respectively, are shown in Table 11 and Table 12. Because of higher encoding rate, some DPDCH symbols remain unused and shall be indicated as DTX.

Table 11: DPDCH and DPCCH fields in compressed mode when puncturing 4 slots

Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame			Bits/ Slot	DPDCH Bits/Slot		DPCCH Bits/Slot			Extra DPDCH symbols for DTX
			DPDCH	DPCCH	TOT		N_{Data1}	N_{Data2}	N_{TFCI}	N_{TPC}	N_{Pilot}	
16	8	512	40	66	110	10	2	2	0	2	4	4
32	16	256	100	110	220	20	2	8	0	2	8	10
32	16	256	80	140	220	20	0	8[1]	2[1]	2	8	0
64	32	128	300	110	440	40	6[1]	24	0	2	8	30
64	32	128	280	140	440	40	4[1]	24	2[1]	2	8	20
128	64	64	600	252	880	80	4[1]	56	8[1,2]	4	8	28
256	128	32	1400	252	1760	160	20[1]	120	8[1,2]	4	8	108
512	256	16	2880	384	3520	320	48[1]	240	8[1,2]	8	16	256
1024	512	8	6080	384	7040	640	112[1]	496	8[1,2]	8	16	576
2048	1024	4	12480	384	14080	1280	240[1]	1008	8[1,2]	8	16	1216

1) This figure does not take into account the extra TFCI bits from deleted slots

2) If no TFCI then the TFCI field is blank

Note: Compressed mode with puncturing cannot be used for SF=512 with TFCI

Table12: DPDCH and DPCCH fields in compressed mode frame when puncturing 3 slots

Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame			Bits/ Slot	DPDCH Bits/Slot		DPCCH Bits/Slot			Extra DPDCH symbols for DTX
			DPDCH	DPCCH	TOT		N_{Data1}	N_{Data2}	N_{TFCI}	N_{TPC}	N_{Pilot}	
16	8	512	40	72	120	10	2	2	0	2	4	8
32	16	256	100	120	240	20	2	8	0	2	8	20
32	16	256	80	150	240	20	0	8[1]	2[1]	2	8	10
64	32	128	300	120	480	40	6	24	0	2	8	60
64	32	128	280	150	480	40	4[1]	24	2[1]	2	8	50
128	64	64	600	264	960	80	4[1]	56	8[1,2]	4	8	96
256	128	32	1400	264	1920	160	20[1]	120	8[1,2]	4	8	256
512	256	16	2880	408	3840	320	48[1]	240	8[1,2]	8	16	552
1024	512	8	6080	408	7680	640	112[1]	496	8[1,2]	8	16	1192
2048	1024	4	12480	408	15360	1280	240[1]	1008	8[1,2]	8	16	2472

1) This figure does not take into account the extra TFCI bits from deleted slots

2) If no TFCI then the TFCI field is blank

Note: Compressed mode with puncturing cannot be used for SF=512 with TFCI

~~4.4.2.2~~4.4.3.2 Method A2: By puncturing, for services that allow larger delay

Other methods of supporting compressed mode may be considered as options. For example, with services that allows for a larger delay, e.g. data services with interleaving over several frames, multiple frames might be compressed together in order to create a short measurement slot. As an example, for a 2 Mbps service, with interleaving of 5 frames (50 ms), a 5 ms idle slot can be created by puncturing only 10% of 5 frames, as illustrated in Figure 19~~8~~.

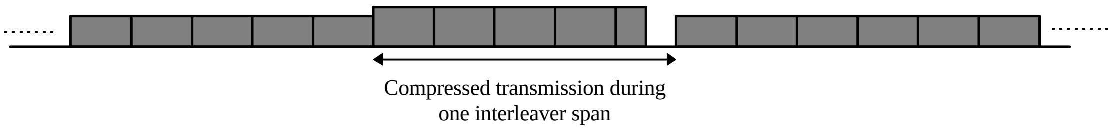


Figure 19~~8~~: Multi-frame compressed mode for long-delay services

~~4.4.2.3~~4.4.3.3 Method B: By reducing the spreading factor by 2

During compressed mode, the spreading factor (SF) can be reduced by 2 to enable the transmission of the information bits in the remaining time slots of a compressed frame. ~~This can accommodate up to 50% idle slots per frame which is the maximum compression factor required. Additional rate matching is required if there are less than 50% idle slots. Reducing the spreading factor will normally be used if rate matching alone is not sufficient to transmit all information bits in compressed mode. Use of this method for uplink compressed mode is for further study.~~

On the downlink, UTRAN can also order the UE to use a different scrambling code in compressed mode than in normal mode. If the UE is ordered to use a different scrambling code in compressed mode, then there is a one-to-one mapping between the scrambling code used in normal mode and the one used in compressed mode, as described in TS 25.213 section 5.2.1.

The DPCCH fields in compressed mode are defined in Table 13 and 14.

Table 13: Uplink DPCCH fields in compressed mode

Format number	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{pilot}	N_{TPC}	N_{TFCI}	N_{FBI}	Transmitted slots per radio frame
0	15	15	256	150	10	6	2	2	0	15
0A	15	15	256	150	10	5	2	3	0	10-14
0B	15	15	256	150	10	4	2	4	0	8-9
1	15	15	256	150	10	8	2	0	0	8-15
2	15	15	256	150	10	5	2	2	1	15
2A	15	15	256	150	10	4	2	3	1	10-14
2B	15	15	256	150	10	3	2	4	1	8-9
3	15	15	256	150	10	7	2	0	1	8-15
4	15	15	256	150	10	6	2	0	2	8-15
5	15	15	256	150	10	5	1	2	2	15
5A	15	15	256	150	10	4	1	3	2	10-14
5B	15	15	256	150	10	3	1	4	2	8-9

Table 14: Downlink DPDCH and DPCCH fields in compressed mode

Format number	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame			Bits/ Slot	DPDCH Bits/Slot		DPCCH Bits/Slot		
				DPDCH	DPCCH	TOT		N_{Data1}	N_{Data2}	N_{TFC}	N_{TPC}	N_{Pilot}
0A	30	15	256	120	180	300	20	4	4	0	4	8
1A	30	15	256	60	240	300	20	0	4	4	4	8
2A	60	30	128	480	120	600	40	4	28	0	4	4
3A	60	30	128	420	180	600	40	0	28	4	4	4
4A	60	30	128	420	180	600	40	4	24	0	4	8
5A	60	30	128	360	240	600	40	0	24	4	4	8
6A	60	30	128	300	300	600	40	4	16	0	4	16
7A	60	30	128	240	360	600	40	0	16	4	4	16
8A	120	60	64	1020	180	1200	80	12	56	0	4	8
9A	120	60	64	960	240	1200	80	8	56	4	4	8
10A	120	60	64	900	300	1200	80	12	48	0	4	16
11A	120	60	64	840	360	1200	80	8	48	4	4	16
12A	240	120	32	1800	600	2400	160	8	112	16*	8	16
13A	480	240	16	4200	600	4800	320	40	240	16*	8	16
14A	960	480	8	8640	960	9600	640	96	480	16*	16	32
15A	1920	960	4	18240	960	19200	1280	224	992	16*	16	32

* If no TFCI, then the TFCI field is blank.

In downlink compressed mode through method B, the number of bits in the TPC, Pilot, and FBI fields are doubled. Symbol repetition is used to fill up the fields. Denote the bits in one of these fields in uncompressed mode by $x_1, x_2, x_3, \ldots, x_X$. In compressed mode the following bit sequence is sent in corresponding field: $x_1, x_2, x_1, x_2, x_3, x_4, x_3, x_4, \ldots, x_X$.

~~4.4.3~~4.4.4 Transmission gap position

Transmission gaps can be placed at both fixed position and adjustable position for each purpose such as interfrequency power measurement, acquisition of control channel of other system/carrier, and actual handover operation.

~~4.4.3.1~~4.4.4.1 Fixed transmission gap position

The transmission gaps can be placed onto fixed positions. When using single frame method, the fixed transmission gap is located within the compressed frame depending on the transmission gap length (TGL) as shown in Figure ~~19~~20 (1). When using double frame method, the fixed transmission gap is located on the center of two connected frames as shown in Figure ~~19~~20 (2). Table 13 shows the parameters for the fixed transmission gap position case.

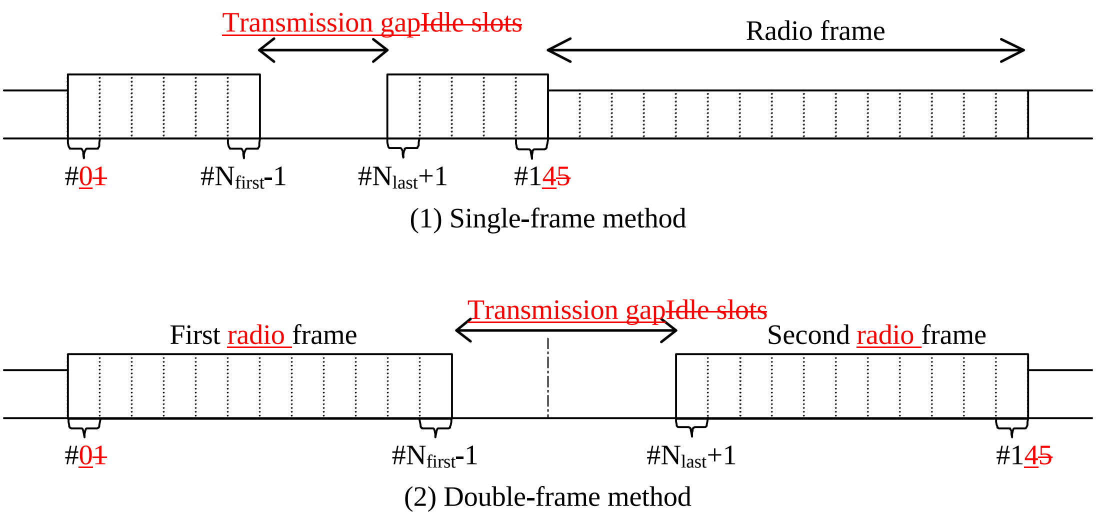


Figure 20~~19~~: Fixed transmission gap ~~lengths~~ position

Table 15~~3~~: Parameters for fixed transmission gap position

	Single-frame method		Double-frame method	
TGL~~ransmission gap~~	**N_{first}**	**N_{last}**	**N_{first}**	**N_{last}**
3	7~~8~~	9~~10~~	14~~5~~ in first frame	1~~2~~ in second frame
4	6~~7~~	9~~10~~	13~~4~~ in first frame	1~~2~~ in second frame
7	6~~7~~	12~~13~~	12~~3~~ in first frame	3~~4~~ in second frame
10	N.A.	N.A.	10~~1~~ in first frame	4~~5~~ in second frame
14	N.A.	N.A.	8~~9~~ in first frame	6~~7~~ in second frame

<Ericsson's note: The table has been changed to reflect numbering of slots from 0 to 14.>

~~4.4.3.2~~4.4.4.2 Adjustable transmission gap position

Position of transmission gaps can be adjustable/relocatable for some purpose e.g. data acquisition on certain position as shown in Figure 21~~0~~. Parameters of the adjustable transmission gap ~~lengths~~ positions are calculated as follows:

~~N_{idle}~~TGL is the number of consecutive idle slots during compressed mode, as shown in Table 15~~3~~,

~~N_{idle} = 3,4,5,6,8,10,16.~~

<Ericssons' note: Table 15 was changed at the last WG1 meeting. The changes were not reflected in this section. Note that it is not clear why a table with heading saying fixed transmission gap position is referenced in this section. Further, fixed gap position is a special case of adjustable so why are two sections needed?>

TGL = 3, 4, 7, 10, 14

<Ericssons' note: The equations have been changed so that they are valid for 15 slots numbered 0 to 14. It is not clear from this section if bits can be moved from one frame to another. Our understanding is that this is not allowed, i.e. minimum number of transmitted slots per frame is 8.>

N_{first} specifies the starting slot of the consecutive idle slots,

N_{first} = 0, 1, 2, 3,…, 14~~6~~.

N_{last} shows the number of the final idle slot and is calculated as follows;

If N_{first} + TGL~~N_{idle}~~ ≤~~<=~~ 15~~7~~, then N_{last} = N_{first} + TGL~~N_{idle}~~ –1 (in the same frame), If N_{first} + TGL~~N_{idle}~~ > 15~~7~~, then N_{last} = (N$_{first}$ + TGL~~N_{idle}~~-1) mod 15~~ – 17~~ (in the next frame).

When the transmission gap spans two consecutive radio frames, N_{first} and TGL must be chosen so that at least 8 slots in each radio frame are transmitted.

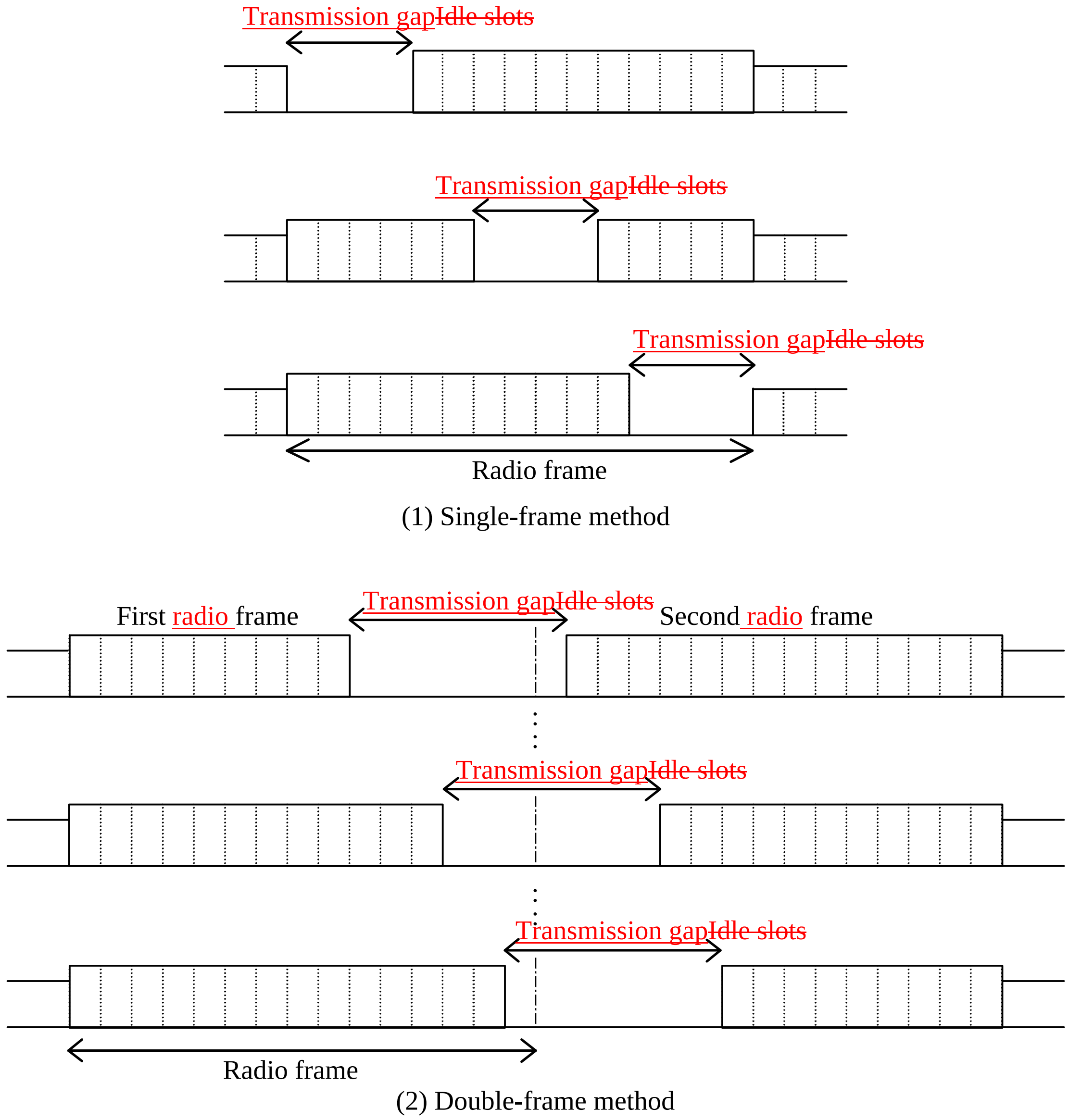


Figure 21~~0~~: ~~Concept of a~~Adjustable transmission gap lengths position

<*Ericsson's note: The number of slots has been reduced to 15.~~Editors note: Adjustment needed~~*>

~~4.4.3.3~~4.4.4.3 Parameters for downlink compressed mode

< Editor's note: WG1 suggestion is that there is need for further clarifications in Table 16~~4~~ (e.g. rationales between change of coding rate/puncturing/change of spreading factor and idle time size, spreading factor range for different modes, etc.).>

Table 15~~4~~ shows the detailed parameters for each transmission gap length~~number of idle slots~~. This is an example for the 10ms interleaving depth. Application of compressed mode for interleaving depths other than 10ms are for further study. Each transmission gap length is ~~number of idle slots are~~ classified for three cases:

Case 1 - Power measurement : ~~Number of idle slots~~TGL = 3, 4, 5, 6.

Case 2 - Acquisition of control channels : ~~Number of idle slots~~TGL = 3, 4, 5, 6, 8, 10.

Case 3 - Actual handover operation : ~~Number of idle slots~~TGL = 10, 16.

Table 164: Parameters for downlink compressed mode

TGL~~Number of idle~~ (slots)	Mode	Spreading Factor	TGL~~Idle length~~ [ms]	Transmission time reduction method	TG~~Idle frame~~ combining
3	A	512 - 256	1.63 - 1.63	Puncturing Spreading facter reduction by 2	(S)/(D)
	B	128 - 4	1.63 - 1.75		
4	A	512 - 256	2.25 - 2.25	Puncturing (D) Spreading facter reduction by 2(D)/(S)	
	B	128 - 4	2.25 - 2.37		
5	A	512 - 256	2.87 - 2.87		
	B	128 - 4	2.87 – 2.99		
6	A	512 - 256	3.50 - 3.50	Puncturing (D)/(S) Spreading factor reduction by 2 (S)/(D)	
	B	128 - 4	3.50 - 3.62		
7	A	512 - 256	4.75 - 4.75	Spreading factor reduction by 2 (S)	
	B	128 - 4	4.75 - 4.87		
10	A	512 - 256	6.00 - 6.00	Puncturing Spreading factor reduction by 2	(D)
	B	128 - 4	6.00 - 6.12		
14	A	512 - 256	9.75 - 9.75	Puncturing Spreading factor reduction by 2	
	B	128 - 4	9.75 - 9.87		

(S): Single-frame method as shown in Figure 19 (1).

(D): Double-frame method as shown in Figure 19 (2).

SF="2/1": "2" is for (S) and "1" is for (D).