

Agenda item:

Source: Ericsson
Title: CR 25.212-005: Compressed mode by higher layer scheduling
Document for: Decision

It was proposed in TSGR1#8(99)g77 that compressed mode by higher layer scheduling should be allowed. This was agreed at TSG-RAN Working Group 1 meeting #8 and it was recommended that a CR should be generated from the text proposal in g77.

This contribution contains a CR based on the text proposal in g77. Compared to the text proposal in g77, the following changes have been made:

4.2.9.1: Clarified that X_i is the number of bits **per TTI**.

4.2.9.2: In 25.211 N_{data1} and N_{data2} are defined per slot. Hence, $N_{data} = 15N_{data1} + 15N_{data2}$.
There was an error in the definition of U . The correct relation is $U = N_{data} - N_{TGL}$.

Figure 18: After a discussion on the reflector there seemed to be agreement on moving the TFCI field to after the TPC field. This change is reflected in Figure 18.

Table 15: Replaced FFS for compressed mode by SF reduction on SF=4 by not supported. No solution with SF=4 and SF reduction has been presented so far and it is therefore proposed that it is not supported in release 99. This was also stated in the agreed text proposal of g77 for 25.211 but the sentence below table 15 was not covered.

4 Multiplexing, channel coding and interleaving

4.1 General

Data stream from/to MAC and higher layers (Transport block / Transport block set) is encoded/decoded to offer transport services over the radio transmission link. Channel coding scheme is a combination of error detection, error correcting, rate matching, interleaving and transport channels mapping onto/splitting from physical channels.

4.2 Transport-channel coding/multiplexing

Data arrives to the coding/multiplexing unit in form of transport block sets once every transmission time interval. The transmission time interval is transport-channel specific from the set { 10 ms, 20 ms, 40 ms, 80 ms }.

The following coding/multiplexing steps can be identified:

- Add CRC to each transport block (see section 4.2.1)
- Transport block concatenation and code block segmentation (see section 4.2.2)
- Channel coding (see section 4.2.3)
- Rate matching (see section 4.2.7)
- Insertion of discontinuous transmission (DTX) indication bits (see section 4.2.9)
- Interleaving (two steps, see sections 4.2.4 and 4.2.11)
- Radio frame segmentation (see section 4.2.6)
- Multiplexing of transport channels (see section 4.2.8)
- Physical channel segmentation (see section 4.2.10)
- Mapping to physical channels (see section 4.2.12)

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

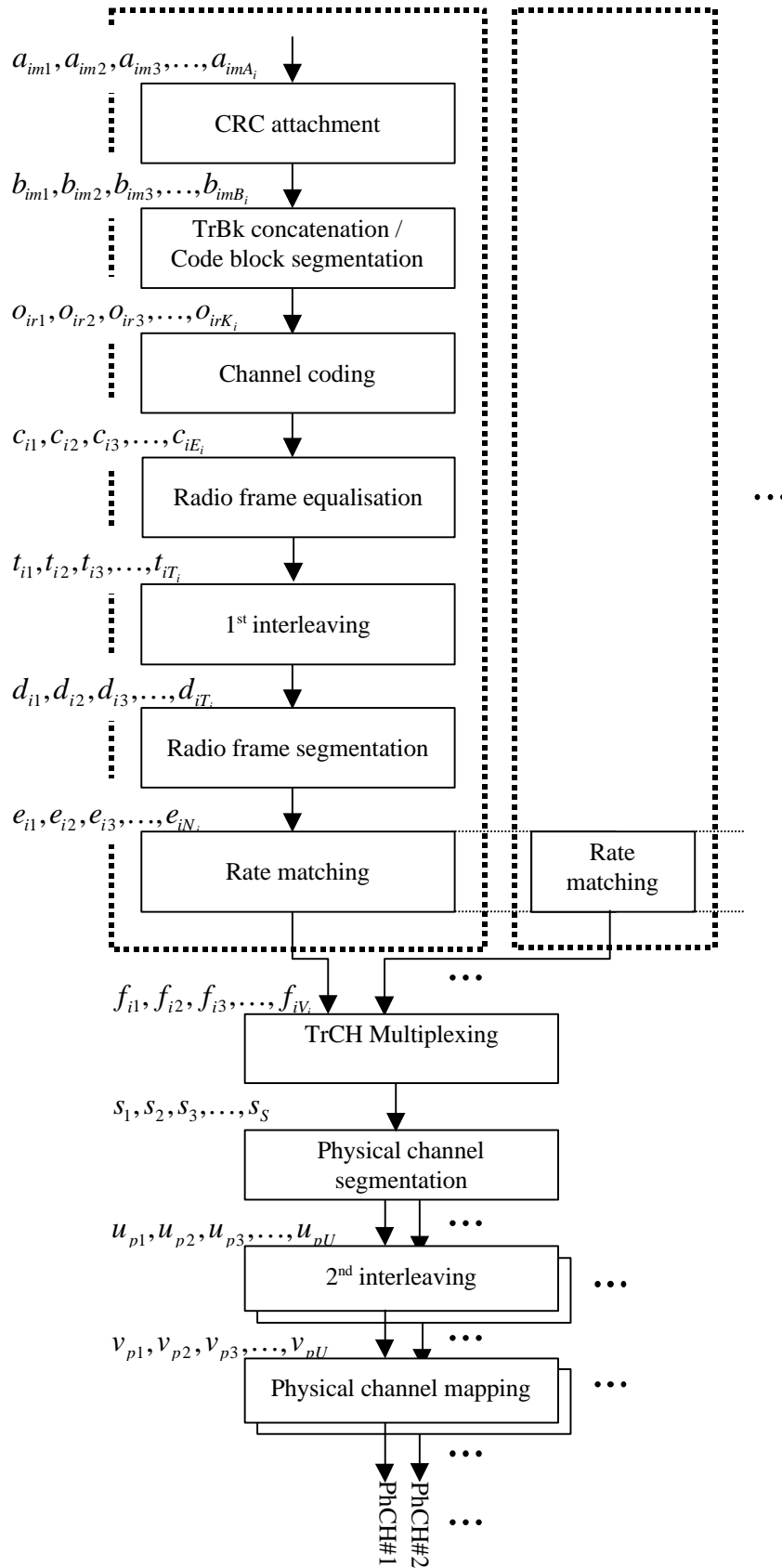


Figure 1: Transport channel multiplexing structure for uplink

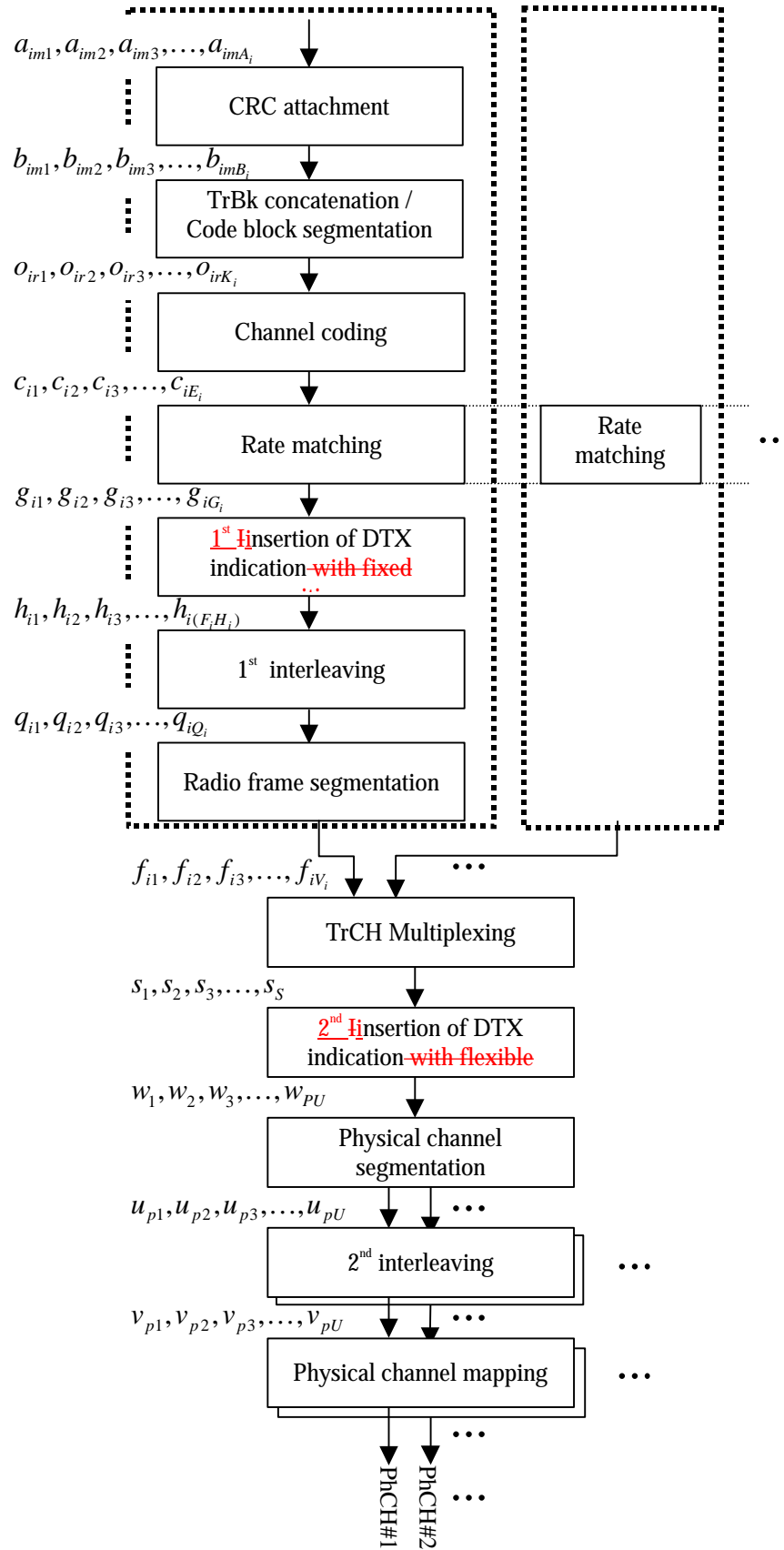


Figure 2: Transport channel multiplexing structure for downlink

The single output data stream from the TrCH multiplexing is denoted *Coded Composite Transport Channel (CCTrCH)*. A CCTrCH can be mapped to one or several physical channels.

$$Z_{ij} = \left[\frac{\sum_{m=1}^i RM_m \cdot N_{mj}}{\sum_{m=1}^I RM_m \cdot N_{mj}} \cdot N_{data,j} \right] \text{ for all } i = 1 \dots I \quad (1)$$

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

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:

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

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

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

else

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

Sort SET2 in ascending order

$$N_{data} = \min \text{SET2}$$

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

$$N_{data} = \text{follower of } N_{data} \text{ in SET2}$$

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 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 relations:

$$N_{data,j}^{cm} = 2N_{data,j} - N_{TGL} \quad N_{data,j}^{cm} = 2N_{data,j} - 2N_{TGL}, \text{ wherefor compressed mode by spreading factor reduction}$$

$N_{data,j}^{cm} = N_{data,j} - N_{TGL}$ for compressed mode by higher layer scheduling

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

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

If $DN_{ij} = 0$ then the output data of the rate matching is the same as the input data and the rate matching algorithm of section 4.2.7.4 does not need to be executed.

Otherwise, for determining e_{ini} , e_{plus} , e_{minus} , and N the following parameters are needed (regardless if the radio frame is compressed or not):

For convolutional codes,

$$q = \lfloor N_{ij} / (|\Delta N_{ij}|) \rfloor$$

if q is even

$$\text{then } q' = q - \text{gcd}(q, F_i) / F_i \text{ -- where } \text{gcd}(q, F_i) \text{ means greatest common divisor of } q \text{ and } F_i$$

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

else

$$q' = q$$

endif

for $x = 0$ to $F_i - 1$

$$S(I_F(\lceil x * q' \rceil \bmod F_i)) = (\lceil x * q' \rceil \text{ div } F_i)$$

end for

$$\Delta N = \Delta N_{ij}$$

$$a = 2$$

For each radio frame, the rate-matching pattern is calculated with the algorithm in section 4.2.7.4, where :

$$N = N_{i,j}, \text{ and}$$

$$e_{ini} = (a \cdot S(n_i) \cdot |\Delta N| + N) \bmod a \cdot N, \text{ if } e_{ini} = 0 \text{ then } e_{ini} = a \cdot N.$$

$$e_{plus} = a \cdot N$$

$$e_{minus} = a \cdot |\Delta N|$$

puncturing for $DN < 0$, repeating otherwise.

For turbo codes, if repetition is to be performed, such as $DN_{ij} > 0$, parameters for turbo codes are the same as parameter for convolutional codes.

If puncturing is to be performed, parameters are as follows.

$a=2$ for Y sequence, and

$a=1$ for Y' sequence.

4.2.9.1 1st insertion of DTX indication bits ~~with fixed positions~~

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 $g_{i1}, g_{i2}, g_{i3}, \dots, g_{iG_i}$, where G_i is the number of bits in one TTI of TrCH i . Denote the number of bits reserved for in one radio frame of TrCH i by H_i , i.e. ~~the maximum number of bits in a radio frame for any transport format of TrCH i . In normal or compressed mode 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 . In compressed mode by higher layer scheduling, only a subset of the TFC Set is allowed. From this subset it is possible to derive which TFs on each TrCH that are allowed. The maximum number of bits belonging to one TTI of~~

~~TrCH i for the allowed TFs is denoted by X_i . H_i is then calculated as $H_i = \left\lceil \frac{X_i}{F_i} \right\rceil$, where F_i is the number of radio~~

~~frames in a TTI of TrCH i is denoted by F_i . The bits output from the DTX insertion are denoted by $h_{i1}, h_{i2}, h_{i3}, \dots, h_{i(F_i H_i)}$. Note that these bits are three valued. They are defined by the following relations:~~

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

$$h_{ik} = \mathbf{d} \quad k = G_i+1, G_i+2, G_i+3, \dots, F_i H_i$$

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

4.2.9.2 2nd insertion of DTX indication bits ~~with flexible positions~~

NOTE: Below, it is assumed that all physical channels belonging to the same CCTrCH use the same SF. Hence, $U_p=U=\text{constant}$.

~~This step of inserting DTX indication bits is used only if the positions of the TrCHs in the radio frame are flexible. 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 $s_1, s_2, s_3, \dots, s_S$, where S is the number of bits from TrCH multiplexing. The number of PhCHs is denoted by P and the number of bits in one radio frame, including DTX indication bits, for each PhCH by U . The number of available bits on the PhCH is denoted by N_{data} and $N_{data}=15N_{data1}+15N_{data2}$, where N_{data1} and N_{data2} are defined in [25.211]. In normal mode $U=N_{data}$. In compressed mode N_{data} is changed from the value in normal mode. The exact value of N_{data} is dependent on the TGL and the transmission time reduction method, which are signalled from higher layers. The number of bits that the transmission is turned off is denoted by N_{TGL} and defined as:

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

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

In compressed mode $U=N_{data}-N_{TGL}$.

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

$$w_k = s_k \quad k = 1, 2, 3, \dots, S$$

$$w_k = \mathbf{d} \quad k = S+1, S+2, S+3, \dots, PU$$

where DTX indication bits are denoted by \mathbf{d} . Here $s_k \in \{0,1\}$ and $\mathbf{d} \notin \{0,1\}$.

4.2.10 Physical channel segmentation

NOTE: Below, it is assumed that all physical channels belonging to the same CCTrCH use the same SF. Hence, $U_p=U=\text{constant}$.

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 $x_1, x_2, x_3, \dots, x_Y$, where Y 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 $u_{p1}, u_{p2}, u_{p3}, \dots, u_{pU}$, where p is PhCH number and U is the number of bits in one radio frame for each PhCH, i.e. $U = \frac{Y}{P}$. The relation between x_k and u_{pk} is given below.

Bits on first PhCH after physical channel segmentation:

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

Bits on second PhCH after physical channel segmentation:

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

...

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

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

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 $s_1, s_2, s_3, \dots, s_S$. Hence, $x_k = s_k$ and $Y = S$.

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

~~If fixed positions of the TrCHs in a radio frame are used then the bits input to the physical segmentation are denoted by $s_1, s_2, s_3, \dots, s_S$. Hence, $x_k = s_k$ and $Y = S$.~~

~~If flexible positions of the TrCHs in a radio frame are used then t~~The bits input to the physical segmentation are denoted by $w_1, w_2, w_3, \dots, w_{(PU)}$. Hence, $x_k = w_k$ and $Y = PU$.

4.2.11 2nd interleaving

The 2nd interleaving is a block interleaver with inter-column permutations. The bits input to the 2nd interleaver are denoted $u_{p1}, u_{p2}, u_{p3}, \dots, u_{pU}$, where p is PhCH number and U is the number of bits in one radio frame for one PhCH.

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

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	$b_{1,14}^1$	$b_{1,14}^2$	$b_{1,14}^3$	$b_{1,14}^4$	$b_{2,14}^1$	$b_{2,14}^2$	$b_{2,14}^3$	$b_{2,14}^4$
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 $c_0, c_1, c_2, c_3, c_4, \dots, c_C$, where:

- $c_k = b_k$, $C = 29$, when there are 2 TFCI bit in each slot.
- $c_0 = b_0^4, c_1 = b_0^3, c_2 = b_0^2, c_3 = b_0^1, c_4 = b_1^4, c_5 = b_1^3, \dots, c_{119} = b_{14}^1$, when there are 8 TFCI bits in each slot.
- $c_0 = b_{2,0}, c_1 = b_{1,0}, c_3 = b_{2,1}, c_4 = b_{1,1}, \dots, c_{29} = b_{1,14}$, in split mode when there are 2 TFCI bits in each slot.
- $c_0 = b_{2,0}^4, c_1 = b_{2,0}^3, c_2 = b_{2,0}^2, c_3 = b_{2,0}^1, c_4 = b_{1,0}^4, c_5 = b_{1,0}^3, \dots, c_{119} = b_{1,14}^1$, 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.

4.3.5.4.1 Compressed mode method A

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.

4.2.5.4.1.1 TGL of 3 slots

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

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

The case when $C = 29$ is illustrated in figure 14.

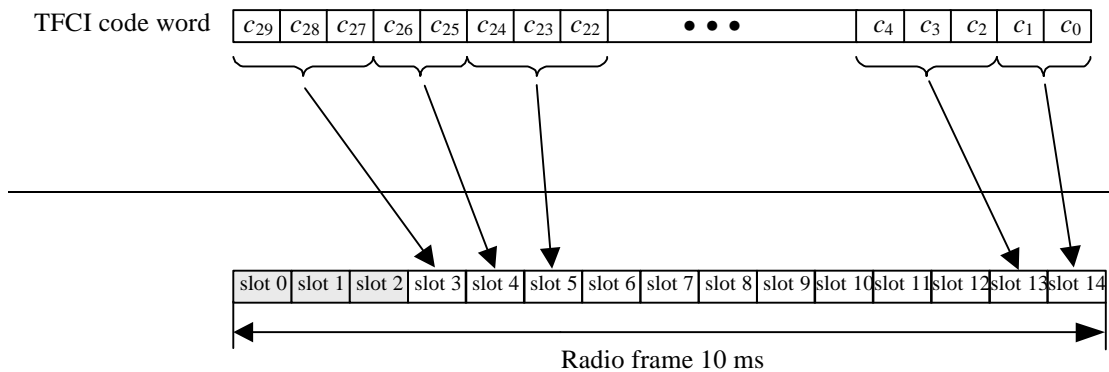


Figure 14: Mapping of TFCI code with TGL of 3 slots.

4.2.5.4.1.2 TGL of 4 slots

Slot number 4 does not contain any TFCI bits.

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

The case when $C = 29$ is illustrated in figure 15.

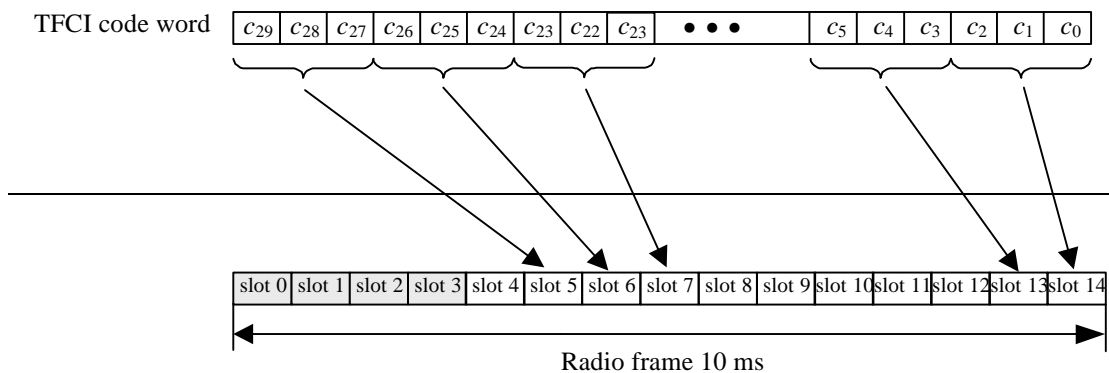


Figure 15: Mapping of TFCI code with TGL of 4 slots

4.3.5.34.12 Uplink C compressed mode method B

4.2.5.4.2.1 Uplink

For uplink compressed mode, by method B the frameslot format is changed so that no TFCI bits are lost. The different frameslot formats in compressed mode and do not match the exact number of TFCI 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 , the repeated bits by d_k , and the number of bits in the TFCI field in a slot by N_{TFCI} . Let $E = 30 - 129 - (N_{first} N_{TFCI}) \bmod 30$. If $N_{last} \neq 14$, 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.

$$d_{D-31} = c_{E \bmod 30}, d_{D-32} = c_{(E-1) \bmod 30}, d_{D-33} = c_{(E-2) \bmod 30}, \dots, d_0 = c_{(E-(D-31)) \bmod 30}$$

The bits are mapped to the slots in descending order starting with the original bits and followed by the repeated ones, i.e. c_{29} 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.

4.32.5.34.2.2 Downlink compressed mode

<Editor's note: Detailed description for downlink is FFS>

For downlink compressed mode, the slot format is changed so that no TFCI 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 in the last TFCI fields.

The bits are mapped to the slots in descending order, i.e. c_C is sent as first bit in the TFCI field of the first transmitted slot and c_0 as the last bit. If the TFCI fields can contain more than C bits, DTX is used for the last bits in the last transmitted slot(s).

4.4 Compressed 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 transmission gap position with single frame method, 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 4.4.3). 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.

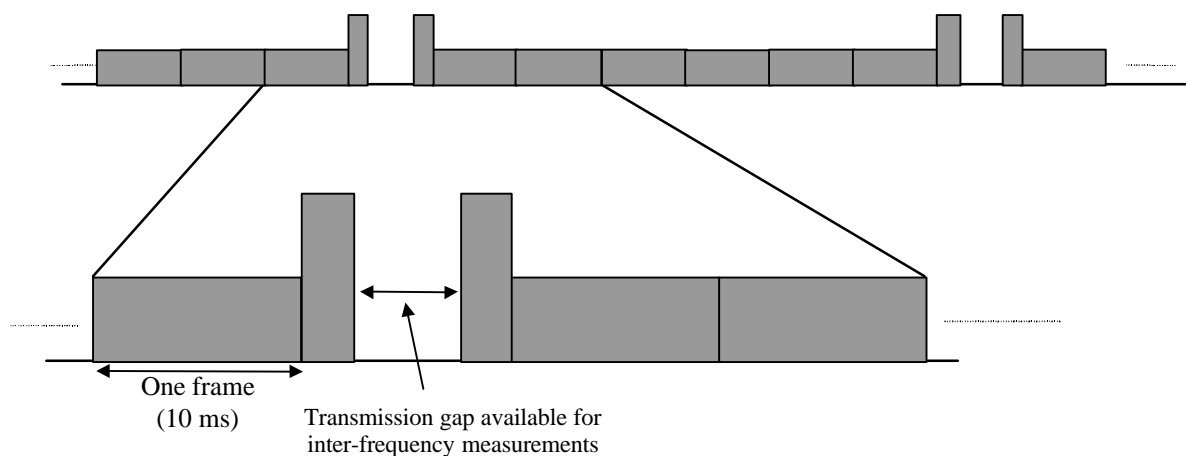


Figure 16: Compressed mode transmission

4.4.1 Frame structure in the uplink

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

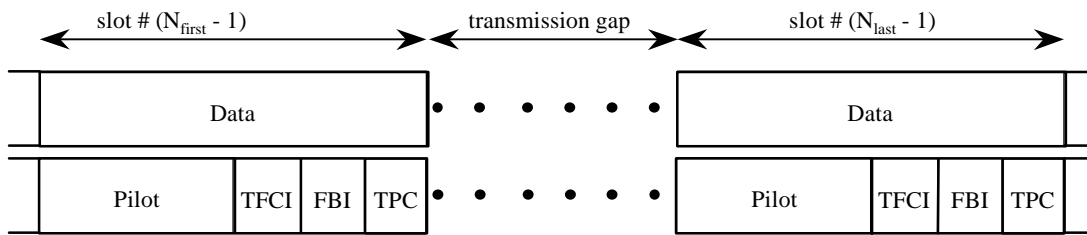
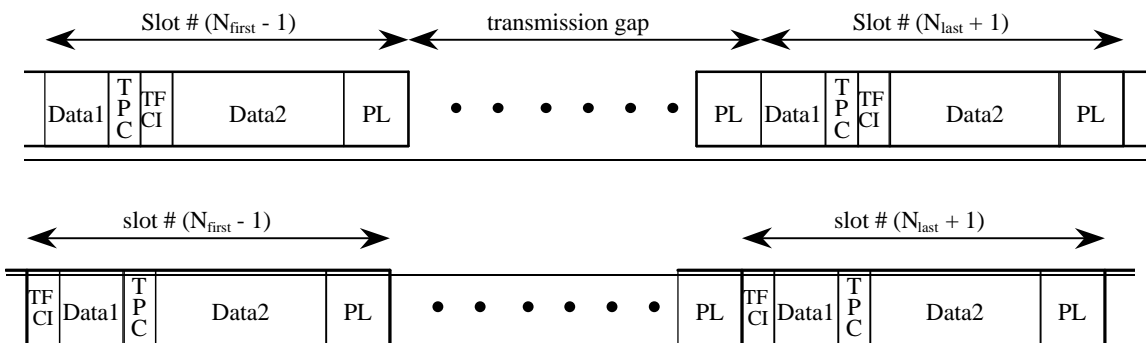


Figure 17: Frame structure in uplink compressed transmission

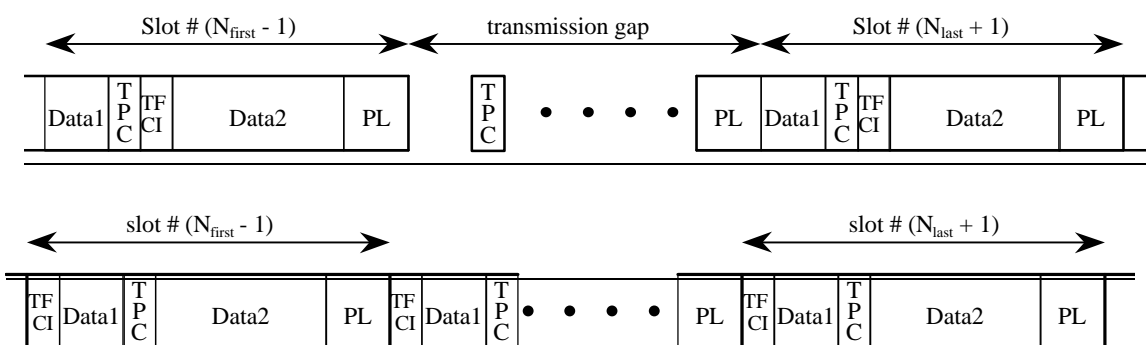
4.4.2 Frame structure types in the downlink

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

- With frame structure of type A, the pilot field of the last slot in the transmission gap is transmitted. BTS transmission is turned off during the rest of the transmission gap from the beginning of TFCI field in slot N_{first} until the end of Data2 field in slot N_{last} (figure 18(a)).
- 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. BTS transmission is turned off during the rest of the transmission gap from the beginning of Data2 field in slot N_{first} until the end of Data2 field in slot N_{last} (figure 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 18: 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 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), and higher layer scheduling. In the downlink, ~~both~~ all methods A and B are supported while ~~compressed mode by puncturing is not only method B is~~ 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 mode are listed in [25.211].

4.4.3.1 Method A: Compressed mode B by puncturing

During compressed mode, rate matching (puncturing) is applied for creating transmission gap in one frame. The algorithm for rate matching (puncturing) as described in section 4.2.7 is used.

~~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 (kps)	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}	
15	7.5	512	40	66	110	10	2	2	0	2	4	4
30	15	256	160	44	220	20	2	14	0	2	2	16
30	15	256	140	74	220	20	0	14 ¹	2 ¹	2	2	6
30	15	256	140	66	220	20	2	12	0	2	4	14
30	15	256	120	96	220	20	0	12 ¹	2 ¹	2	4	4
30	15	256	100	110	220	20	2	8	0	2	8	10
30	15	256	80	140	220	20	0	8 ¹	2 ¹	2	8	0
60	30	128	340	66	440	40	6	28	0	2	4	34
60	30	128	320	96	440	40	4 ¹	28	2 ¹	2	4	24
60	30	128	300	110	440	40	6	24	0	2	8	30
60	30	128	280	140	440	40	4 ¹	24	2 ¹	2	8	20
120	60	64	600	252	880	80	4 ¹	56	8 ^{1,2}	4	8	28
240	120	32	1400	252	1760	160	20 ¹	120	8 ^{1,2}	4	8	108
480	240	16	2880	384	3520	320	48 ¹	240	8 ^{1,2}	8	16	256
960	480	8	6080	384	7040	640	112 ¹	496	8 ^{1,2}	8	16	576
1920	960	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 TFCI bits are not used, then DTX shall be used in TFCI field

NOTE: ——— Compressed mode with puncturing cannot be used for SF=512 with TFCI.

Table 12: 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}	
15	7.5	512	40	72	120	10	2	2	0	2	4	8
30	15	256	160	48	240	20	2	14	0	2	2	32
30	15	256	140	78	240	20	0	14 ¹	2 ¹	2	2	22
30	15	256	140	72	240	20	2	12	0	2	4	28
30	15	256	120	102	240	20	0	12 ¹	2 ¹	2	4	18
30	15	256	100	120	240	20	2	8	0	2	8	20
30	15	256	80	150	240	20	0	8 ¹	2 ¹	2	8	10
60	30	128	340	72	480	40	6	28	0	2	4	68
60	30	128	320	102	480	40	4 ¹	28	2 ¹	2	4	58
60	30	128	300	120	480	40	6	24	0	2	8	60
60	30	128	280	150	480	40	4 ¹	24	2 ¹	2	8	50
120	60	64	600	264	960	80	4 ¹	56	8 ^{1,2}	4	8	96
240	120	32	1400	264	1920	160	20 ¹	120	8 ^{1,2}	4	8	256
480	240	16	2880	408	3840	320	48 ¹	240	8 ^{1,2}	8	16	552
960	480	8	6080	408	7680	640	112 ¹	496	8 ^{1,2}	8	16	1192
1920	960	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 TFCI bits are not used, then DTX shall be used in TFCI field

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

4.4.3.2 Method B: Compressed mode B by reducing the spreading factor by 2

During compressed mode, the spreading factor (SF) can be reduced by 2 during one radio frame to enable the transmission of the information bits in the remaining time slots of a compressed frame.

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[3] section 5.2.1.

The uplink DPCCH fields in compressed mode are defined in table 13.

<Editor's note: Downlink fields structure is FFS.>

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

4.4.3.3 Compressed mode by higher layer scheduling

Compressed mode can be obtained by higher layer scheduling. Higher layers then set restrictions so that only a subset of the allowed TFCs are used in compressed mode. The maximum number of bits that will be delivered to the physical layer during the compressed radio frame is then known and a transmission gap can be generated.

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.

4.4.4.1 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 (1). When using double frame method, the fixed transmission gap is located on the center of two connected frames as shown in figure 19 (2). Table 14 shows the parameters for the fixed transmission gap position case.

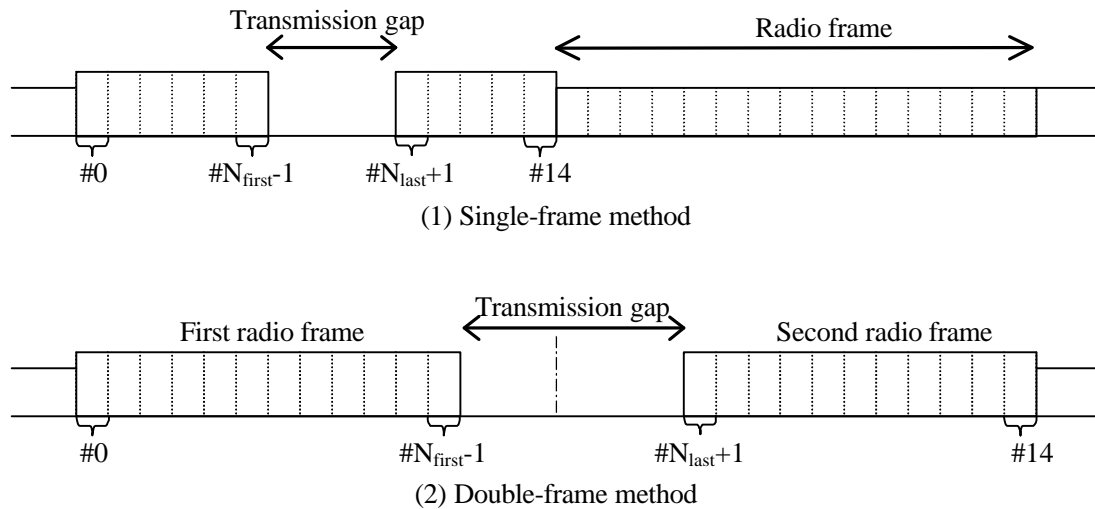


Figure 19: Fixed transmission gap position

Table 14: Parameters for fixed transmission gap position

TGL (slot)	Single-frame method		Double-frame method	
	N _{first}	N _{last}	N _{first}	N _{last}
3	7	9	14 in first frame	1 in second frame
4	6	9	13 in first frame	1 in second frame
7	6	12	12 in first frame	3 in second frame
10	N.A.	N.A.	10 in first frame	4 in second frame
14	N.A.	N.A.	8 in first frame	6 in second frame

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 20. Parameters of the adjustable transmission gap positions are calculated as follows:

TGL is the number of consecutive idle slots during compressed mode,

$TGL = 3, 4, 7, 10, 14$

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

$N_{first} = 0, 1, 2, 3, \dots, 14$.

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

If $N_{first} + TGL \leq 15$, then $N_{last} = N_{first} + TGL - 1$ (in the same frame),

If $N_{first} + TGL > 15$, then $N_{last} = (N_{first} + TGL - 1) \bmod 15$ (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.

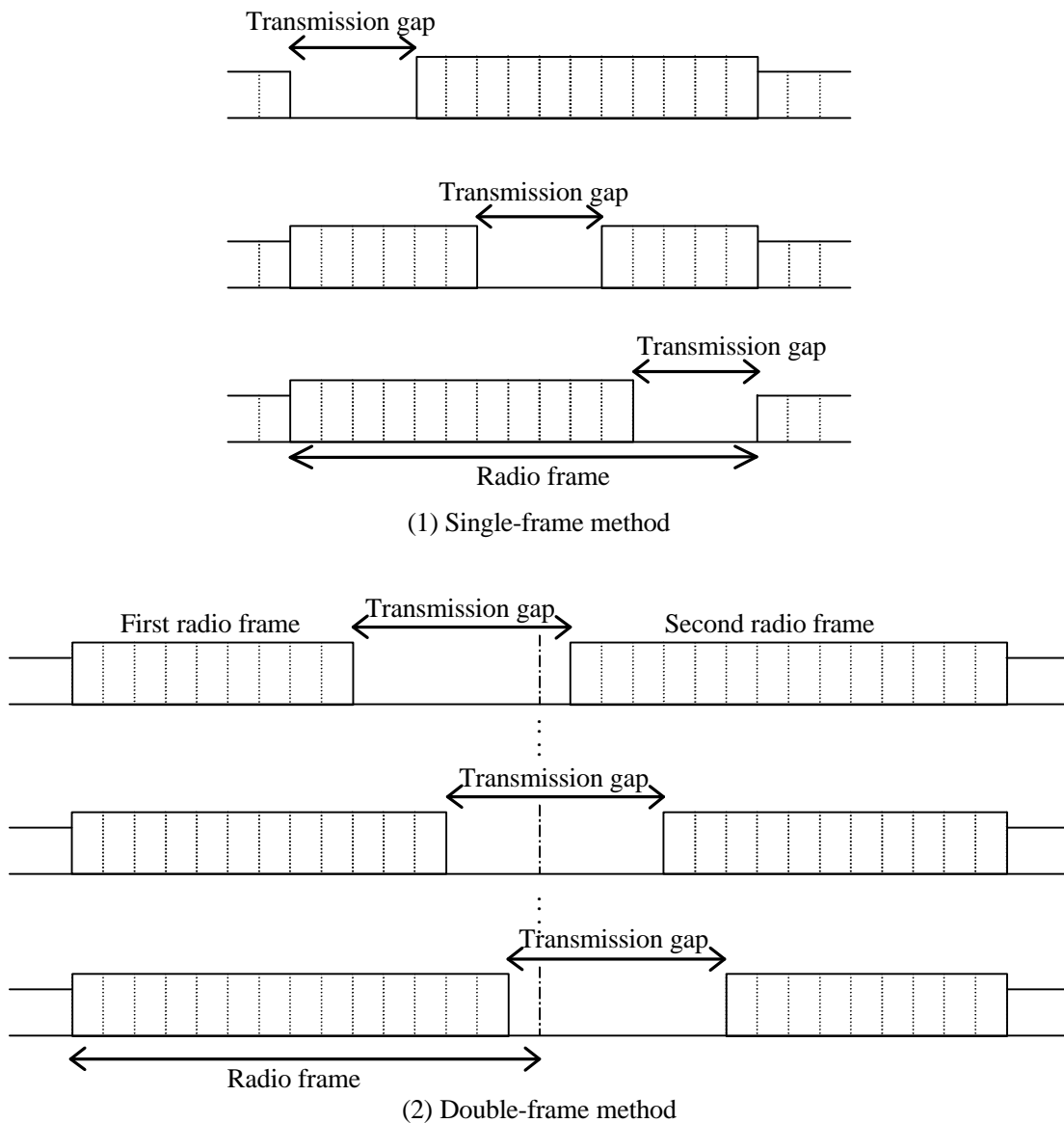


Figure 20: Adjustable transmission gap lengths position

4.4.4.3 Parameters for downlink compressed mode

<Editor's note: WG1 suggestion is that there is need for further clarifications in table 15 (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 shows the detailed parameters for each transmission gap length for the different when transmission time reduction methods A or B are used.

Table 15: Parameters for compressed mode

TGL	Type	Adjustable /fixed gap position	Spreading Factor	Idle length[ms]	Transmission time Reduction method	Idle frame Combining	
3	A	Adjustable Or Fixed	512 - 4	1.73-1.99	Puncturing Spreading factor reduction by 2 <u>Higher layer scheduling</u>	(S) (D) =(1,2),(2,1)	
	B		256- 4	1.60-1.86		(S) (D) =(1,3),(2,2),(3,1)	
4	A		512 - 4	2.40-2.66		(S) (D) =(1,3),(2,2),(3,1)	
	B		256- 4	2.27-2.53		(S) (D)=(1,6),(2,5),(3,4),(4,3),(5,2),(6,1)	
7	A		512 -4	4.40-4.66		(S) (D)=(3,7),(4,6),(5,5),(6,4),(7,3)	
	B		256- 4	4.27-4.53		(D) =(7,7)	
10	A		512 - 4	6.40-6.66			
	B		256- 4	6.27-6.53			
14	A		Fixed	512 - 4		9.07-9.33	
	B			256- 4		8.93-9.19	

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

(D): Double-frame method as shown in figure 19 (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: Details for the use of the Compressed mode by spreading factor reduction method is not supported when with SF=4 is used in normal mode are FFS.