TSG-RAN Working Group 1 meeting #14 **_TSGR1#14(00)0698_**
Oulu, Finland
July 4th – 7th, 2000

Agenda item:

Source: Ericsson

Title: CR 25.212-079: Clarification of compressed mode terminology

Document for: Decision

In several places in TS 25.212, the expression "in compressed mode" or "during compressed mode" is used for specifying the rate matching, DTX insertion and frame structure, but also for the general description of compressed mode.

This CR tries – whenever suitable – to clarify more specifically what is really meant by "compressed mode". In some cases it is the whole TTI containing a compressed frame, in other cases it is just the compressed frame.

It is also clarified that N_{first} and N_{last} can be in different frames. In section 4.4, it is pointed out that the downlink frame structure types A and B are not related to the downlink slot format types A and B (defined in TS 25.211).

A minor editorial change is also inlcuded in the CR, correcting specification names in the reference section.

Document R1-00-0698
e.g. for 3GPP use the format TP-99xxx
or for SMG, use the format P-99-xxx

CHANGE REQUEST

Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.

25.212 CR 079 Current Version: 3.3.0

GSM (AA.BB) or 3G (AA.BBB) specification number ↑ *↑ CR number as allocated by MCC support team*

For submission to: RAN#9
list expected approval meeting # here ↑

for approval	X	strategic		(for SMG use only)
for information		non-strategic		

Form: CR cover sheet, version 2 for 3GPP and SMG *The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc*

Proposed change affects: (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]
(at least one should be marked with an X)

Source: Ericsson **Date:** 2000-07-03

Subject: Clarification of compressed mode terminology

Work item:

Category: *(only one category Shall be marked With an X)*

F	Correction	X
A	Corresponds to a correction in an earlier release	
B	Addition of feature	
C	Functional modification of feature	
D	Editorial modification	

Release:

Phase 2	
Release 96	
Release 97	
Release 98	
Release 99	X
Release 00	

Reason for change: Clarification of "compressed mode" with respect to TTI or frame. Clarification of frame structure A or B. Editorial correction in references section.

Clauses affected: 2, 3.2, 4.2.5.1, 4.2.7.1.2, 4.2.7.2, 4.2.9, 4.4

Other specs Affected:

Other 3G core specifications		→ List of CRs:
Other GSM core specifications		→ List of CRs:
MS test specifications		→ List of CRs:
BSS test specifications		→ List of CRs:
O&M specifications		→ List of CRs:

Other comments:

<--------- double-click here for help and instructions on how to create a CR.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] 3G TS 25.201: "Physical layer – General Description".

[2] 3G TS 25.211: "Physical channels and mapping of transport channels onto physical channels (FDD)".

[3] 3G TS 25.213: "Spreading and modulation (FDD)".

[4] 3G TS 25.214: "Physical layer procedures (FDD)".

[5] 3G TS 25.215: " Physical layer – Measurements (FDD)".

[6] 3G TS 25.221: "Physical channels and mapping of transport channels onto physical channels (TDD)".

[7] 3G TS 25.222: "Multiplexing and channel coding (TDD)".

[8] 3G TS 25.223: "Spreading and modulation (TDD)".

[9] 3G TS 25.224: "Physical layer procedures (TDD)".

[10] 3G TS 25.225: " Physical layer – Measurements (TDD)".

[11] 3G TS 25.302: "Services Provided by the Physical Layer".

[12] 3G TS 25.402: "Synchronisation in UTRAN, Stage 2".

3.2 Symbols

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

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*
sgn(*x*)	signum function, i.e. $\mathrm{sgn}(x) = \begin{cases} 1; & x \geq 0 \\ -1; & x < 0 \end{cases}$
N_{first}	The first slot in the *TG*, located in the first compressed radio frame if the TG spans two frames.
N_{last}	The last slot in the *TG*, located in the second compressed radio frame if the TG spans two frames.
N_{tr}	Number of transmitted slots in a radio frame.

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

i	TrCH number
j	TFC number
k	Bit number
l	TF number
m	Transport block number
n_i	Radio frame number of TrCH i.
p	PhCH number
r	Code block number
I	Number of TrCHs in a CCTrCH.
C_i	Number of code blocks in one TTI of TrCH i.
F_i	Number of radio frames in one TTI of TrCH i.
M_i	Number of transport blocks in one TTI of TrCH i.
$N_{data,j}$	Number of data bits that are available for the CCTrCH in a radio frame with TFC j.
$N_{data,j}^{cm}$	Number of data bits that are available for the CCTrCH in a compressed radio frame with TFC j.
P	Number of PhCHs used for one CCTrCH.
PL	Puncturing Limit for the uplink. Signalled from higher layers
RM_i	Rate Matching attribute for TrCH i. Signalled from higher layers.

Temporary variables, i.e. variables used in several (sub)clauses with different meaning.

x, X
y, Y
z, Z

4.2.5 1st interleaving

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

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

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

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

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

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

$P1_{F_i}(x)$ defines the inter column permutation function for a TTI of length $F_i \times 10$ms, as defined in Table 3 in section 4.2.5.2. $P1_{F_i}(x)$ is the Bit Reversal function of x on $\log_2(F_i)$ bits.

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

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

col = 0

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

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

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

col = col +1

end do

n = 0, m = 0

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

col = n mod F_i

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

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

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

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

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

m = m+1

endif

n = n +1

do

Determination of parameters needed for calculating the rate matching pattern

DN , within one radio frame for each TrCH i is calculated with
1 for all possible transport format combinations and selected every radio frame. $_{data,j}$
subclause

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

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

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

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

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

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

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

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

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

4.2.7.2 Determination of rate matching parameters in downlink

For downlink $N_{data,j}$ does not depend on the transport format combination j. $N_{data,*}$ is given by the channelization code(s) assigned by higher layers. Denote the number of physical channels used for the CCTrCH by P. $N_{data,*}$ is the number of bits available to the CCTrCH in one radio frame and defined as $N_{data,*}=P\times15\times(N_{data1}+N_{data2})$, where N_{data1} and N_{data2} are defined in [2]. Note that contrary to the uplink, the same rate matching patterns are used in ~~normal~~ TTIs containing no comressed radio frames and in TTIs containing radio frames compressed ~~mode~~ by spreading factor reduction or higher layer scheduling.

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

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

For compressed mode by puncturing, in TTIs where some compressed radio frames occur, the puncturing is increased or the repetition is decreased compared to what is calculated according to the rate matching parameters provided by higher layers. This allows to create room for later insertion of marked bits, noted p-bits, which will identify the positions of the gaps in the compressed radio frames.

The amount of additional puncturing corresponds to the number of bits to create the gap in the TTI for TrCH i. In case of fixed positions, it is calculated in addition to the amount of rate matching indicated by higher layers. It is noted $Np_{i,\max}^{TTI,m}$.

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

In case of compressed mode by puncturing and fixed positions, for some calculations, $N'_{data,*}$ is used for radio frames with gap instead of $N_{data,*}$, where $N'_{data,*}=P\times15\times(N'_{data1}+N'_{data2})$. N'_{data1} and N'_{data2} are the number of bits in the data fields of the slot format used for the current compressed mode, i.e. slot format A or B as defined in [2] corresponding to the Spreading Factor and the number of transmitted slots in use.

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

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

$$N_{TGL}=\begin{cases}\dfrac{TGL}{15}\times N'_{data,*}, & \text{if } N_{first}+TGL\le 15\\[2ex] \dfrac{15-N_{first}}{15}\times N'_{data,*}, & \text{in first radio frame of the gap if } N_{first}+TGL>15\\[2ex] \dfrac{TGL-(15-N_{first})}{15}\times N'_{data,*}, & \text{in second radio frame of the gap if } N_{first}+TGL>15\end{cases}$$

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

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

4.2.9 Insertion of discontinuous transmission (DTX) indication bits

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

4.2.9.1 1st insertion of DTX indication bits

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

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

In TTIs containing no compressed frames or frames ~~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~~.~~ and $D_i = F_i \times H_i$.

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

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

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

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

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

4.2.9.2 2nd insertion of DTX indication bits

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

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

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

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

In ~~case of~~ frames compressed ~~mode~~ by puncturing and when fixed positions are used, DTX shall be inserted until $N'_{data,*}$, bits, since the exact room for the gap is already reserved thanks to the earlier insertion of the p-bits. Therefore R is defined as $R = N'_{data,*} / P$.

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

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

For frames compressed by ~~the transmission time~~ spreading factor reduction ~~by SF/2 method in compressed mode~~ $N^{cm}_{data,*} = \frac{N'_{data,*}}{2}$.

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

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

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

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

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

$w_k = s_k$ k = 1, 2, 3, …, S

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

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

4.4 Compressed mode

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

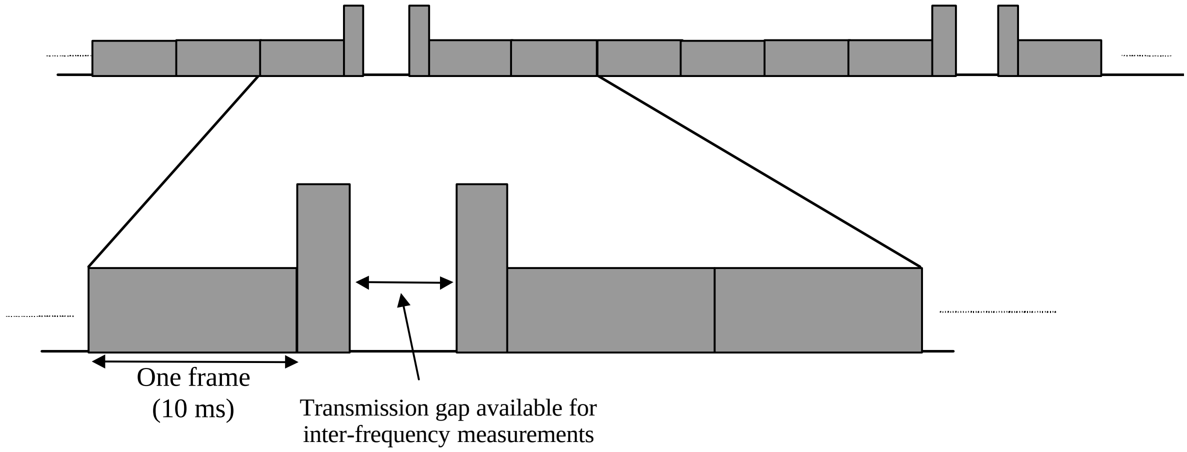


Figure 11: Compressed mode transmission

4.4.1 Frame structure in the uplink

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

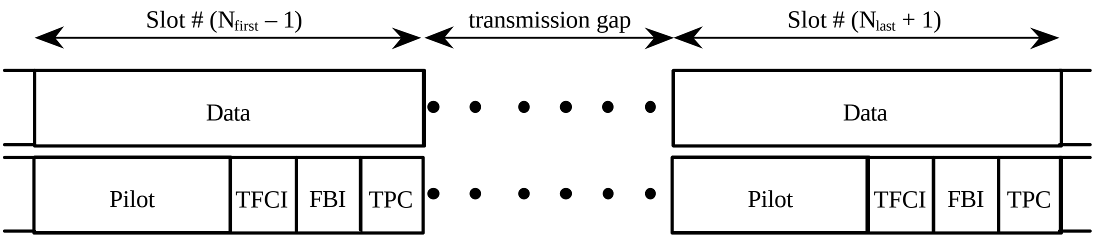


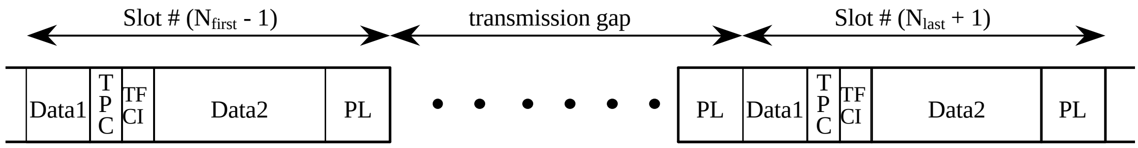
Figure 12: Frame structure in uplink compressed transmission

4.4.2 Frame structure types in the downlink

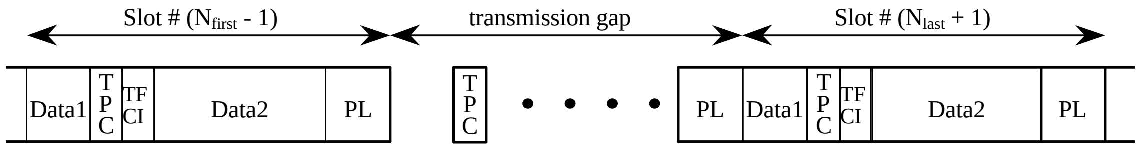
There are two different types of frame structures defined for downlink compressed ~~mode~~frames. Type A maximises the transmission gap length and type B is optimised for power control. The frame structure type A or B is set by higher layers independet from the downlink slot format type A or B.

- With frame structure of type A, the pilot field of the last slot in the transmission gap is transmitted. Transmission is turned off during the rest of the transmission gap (figure 13(a)).

- With frame structure of type B, the TPC field of the first slot in the transmission gap and the pilot field of the last slot in the transmission gap is transmitted. Transmission is turned off during the rest of the transmission gap (figure 13(b)).



(a) Frame structure type A



(b) Frame structure type B

Figure 13: Frame structure types in downlink compressed transmission

4.4.3 Transmission time reduction method

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

4.4.3.1 Compressed mode by puncturing

~~During compressed mode, r~~Rate matching ~~(puncturing)~~ is applied for ~~-~~creating a transmission gap in one or two frames. The algorithm for rate matching ~~(puncturing)~~ as described in subclause 4.2.7 is used.

4.4.3.2 Compressed mode by reducing the spreading factor by 2

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

On the downlink, UTRAN can also order the UE to use a different scrambling code in a compressed ~~mode~~ frame than in ~~normal~~ a non-compressed ~~mode~~frame. If the UE is ordered to use a different scrambling code in a compressed ~~mode~~frame, then there is a one-to-one mapping between the scrambling code used in ~~normal mode~~ the non-compressed frame and the one used in the compressed ~~mode~~frame, as described in ~~TS 25.213~~[3] subclause 5.2.1.

4.4.3.3 Compressed mode by higher layer scheduling

Compressed ~~mode~~ frames can be obtained by higher layer scheduling. Higher layers then set restrictions so that only a subset of the allowed TFCs are used in a compressed ~~mode~~frame. 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. Note that in the downlink, the TFCI field is expanded on the expense of the data fields and this shall be taken into account by higher layers when setting the restrictions on the TFCs. Compressed mode by higher layer scheduling shall not be used with fixed starting positions of the TrCHs in the radio frame.