TSG-RAN Working Group 1 meeting #10 **_TSGR1#10(00)0019_**
Beijing, China
January 18th –21st, 2000

Agenda item: AH 08

Source: Nokia

Title: CR 25.215-022: FDD-FDD interfrequency handover with compressed mode by puncturing

Document for: Decision

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1. Introduction

At the present, TS 25.215 defines that the supported TGL values for measurements performed on FDD interfrequency cell are 7 and 14 timeslots. The possible patterns used with these TGLs and some performance results were given in [1], [2] and [3].

If the only supported TGLs are 7 and 14, it means that in downlink only SF/2 method or higher layer scheduling can be used for FDD-FDD interfrequency handover to ensure good synchronisation performance. The present method with 7 slot gap is such that the 7 slot gap is slided to two different positions in the frame in two consecutive frames, to maximise the SCH symbols captured. Puncturing method cannot be used, since creating 7 slot gap per frame by puncturing is not feasible. The puncturing percentage becomes too high.

It was, however, agreed in RAN #6 meeting, that puncturing method for creating transmission gaps in downlink will also be included into release99 specifications. For that reason, there should be a possibility to use puncturing method also for FDD-FDD interfrequency handover so that good synchronisation performance can be guaranteed.

In this paper we remind everyone of the benefits of puncturing method, which were presented already in WG1 #9 [5]. And after that it is shown which kind of TGL lengths and parameters are needed so that also puncturing method can be used for FDD-FDD interfrequency handover measurements.

2. Benefits of puncturing method

The main reason why the puncturing method was seen to be important, is the code limited situation, because in that case the puncturing method can optimise the downlink capacity, and especially the power budget of the Node B. The tables below show some simple comparison how much SIR target (Node B tx power) has to be increased compared to normal mode in different cases.

Channel	Pintra/Pinter	SIR target increase : due to 2nd scrambling code + due to SF/2
Indoor A	10 dB	4.7 dB+3 dB=7.7 dB
	5 dB	2.5 dB+3 dB=5.5 dB
	0 dB	0.9 dB+3 dB=3.9 dB
Vehicular A	10 dB	3.7 dB+3 dB=6.7 dB
	5 dB	2.7 dB+3 dB=5.7 dB
	0 dB	1.6 dB+3 dB=4.6 dB

Table 1 . The increase of SIR target with SF/2 method and secondary scrambling code [4].

Channel	Coding	SIR target increase: due to puncturing + due to 10/15 compression
Pedestrian A	Convolutional	1 dB+1.7 dB = 2.7 dB
	Turbo	0.5 dB +1.7 dB = 2.2 dB
Vehicular A	Convolutional	2 dB+1.7 dB = 3.7 dB
	Turbo	1.5 dB +1.7 dB = 3.2 dB

Table 2 . The increase of SIR target with puncturing method with TGL = 5 slots per frame [5].

Here Pintra/Pinter = own cell interference/other cell interference, which defines where the UE is in the cell. If Pintra/Pinter=10 dB, the UE is close to its serving Node B. If Pintra/Pinter=0 dB, the UE is at the cell edge, i.e. far away from its serving Node B. The channel models in table 1 and 2 are not exactly the same, but Indoor A and Pedestrian A channel models are very close to each other.

The main point which these tables show, is that with SF/2 method with secondary scrambling code, the increase of SIR target in Indoor A varies between 3.9 dB… 7.7 dB. Since the Pintra/Pinter = own cell interference/other cell interference value, cannot be known (=cannot be measured), it means that the worst case increase of the SIR target has to be used throughout the cell: 7.7 dB, if compressed mode possibility needs to be guaranteed in the whole cell area. The increase of the SIR target by 7.7 dB is a lot, if there is already a code limited situation. It might be that the position in the load curve is already at so high level that there is not enough power left in the Node B's power budget. Or if that is not the case, at least this SIR target increase will waste the downlink capacity.

With puncturing method, the increase of the SIR target in Pedestrian A varies between 2.2…2.7 dB, depending on the coding method. Thus with puncturing method the power budget of Node B can be better optimised.

3. FDD-FDD interfrequency handover with puncturing method

3.1. With the present parameters

Figure 1 below shows the present parameters which define the compressed mode patterns [6].

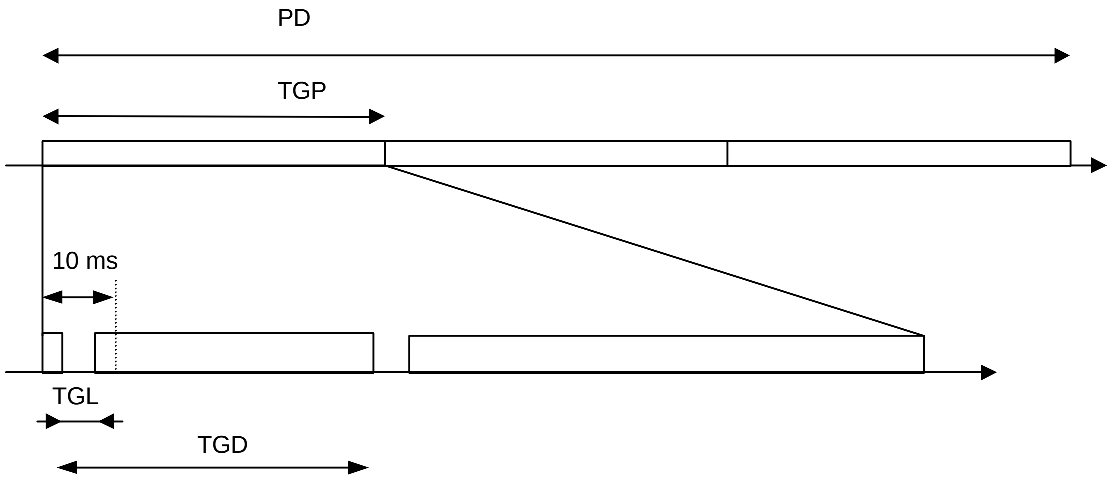

Figure 1. Illustration of compressed mode parameters [6].

If 7 slot length TGL is used, then it can be slided into two different positions in a radio frame in two consecutive frames (frames n and n+i where i ≥ 1), in order to capture sufficient number of SCH, synchronisation symbols. This is done by allowing TGD parameter to be non-integer number of frames, i.e. integer number of slots. See figure 2, which illustrates this [2].

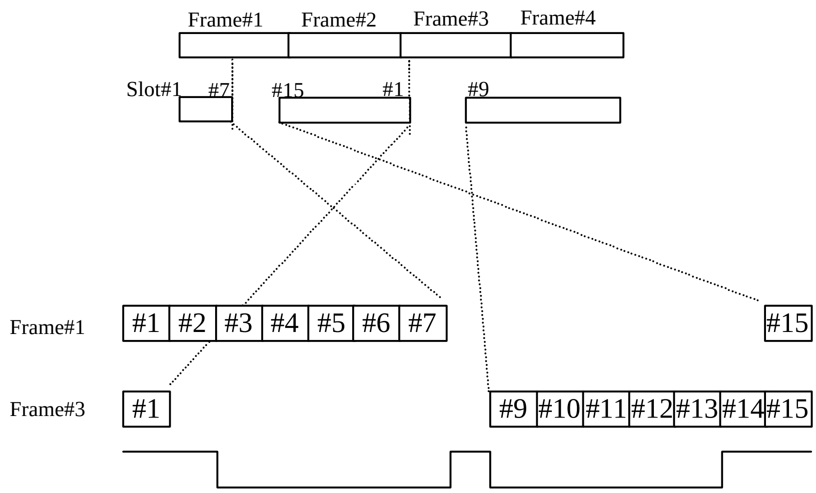

Figure 2. Cell search pattern: TGL=7, TGD=24/15 ; sliding 7 slot gap into different positions in the frame [2].

If 14 slot length TGL is used, then it will always be positioned in the middle of 2 frames. In that case TGD has to be integer number of frames.

Table 3 shows how many SCH symbols can be captured with these two alternative TGL lengths, 7 and 14. The net gap length for each gap, for making measurements, is TGL -$T_{switching}$, where TGL is the gap length, and $T_{switching}$ is the frequency switching time (go and return). Since WG4 has not yet defined the value for $T_{switching}$, both $T_{switching}$ = 1 slot and $T_{switching}$ = 2 slots are considered here.

Method	TGL (slots)	$T_{switching}$ (slots)	No of SCH symbols captured
SF/2 method	7	1	2*(7-1)= 12
	7	2	2*(7-2)= 10
	14	1	14-1= 13
	14	2	14-2= 12

Table 3. Number of SCH symbols captured with SF/2 method.

Table 4 shows how many SCH symbols can be captured with puncturing method, when the maximum feasible gap length per frame created by puncturing is defined to be 5 slots. Thus either two 5 slot length gaps are slided into different positions in a frame in consecutive frames, or 10 slot gap is used with double frame method.

Method	TGL (slots)	$T_{switching}$ (slots)	No of SCH symbols captured
Puncturing	5	1	2*(5-1)= 8
	5	2	2*(5-2)= 6
	10	1	10-1 = 9
	10	2	10-2 = 8

Table 4. Number of SCH symbols captured with puncturing method.

It can be clearly seen, that puncturing method does not allow for capturing a sufficient number of SCH symbols for ensuring a good synchronisation performance. 8-9 SCH symbols out of 15 can be captured, if $T_{switching}$ is 1 slot, and only 6-8 SCH symbols can be captured out of 15, if $T_{switching}$ is 2 slots.

3.2 With modification of one parameter

If it is defined that there can be two different length transmission gaps per TGP, TGL1 and TGL2, then it is possible to use also puncturing method for FDD-FDD interfrequency handover with good performance. Figure 3 illustrates this idea.

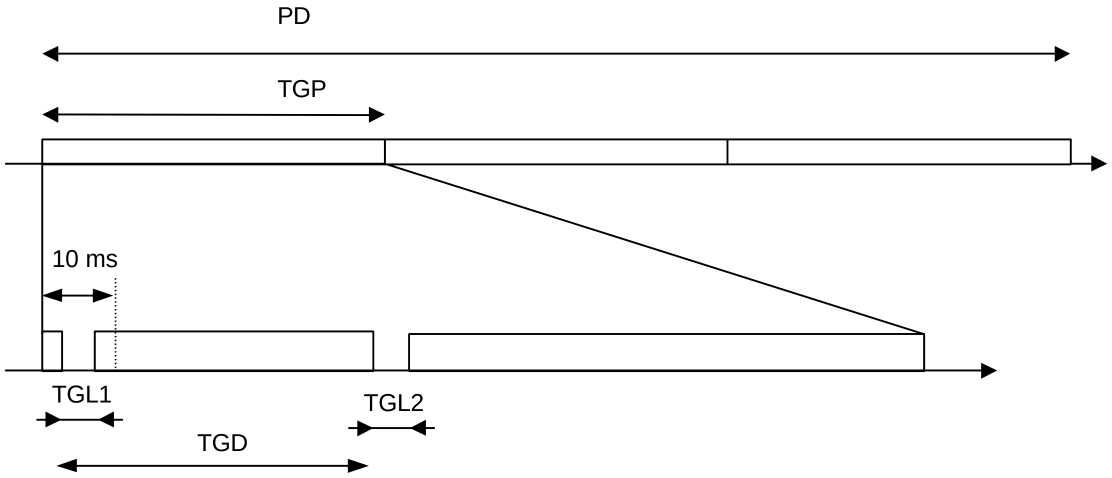

Figure 3. Illustration of compressed mode parameters.

If we now define that TGL1=10 slots in the middle of two frames (double frame idea) and TGL2=5 slots (single frame) in some later frame, then we can still have at maximum 5 slots gap created by puncturing per one frame. Figure 4 shows how the gaps could be slided to maximise the number of SCH symbols captured.

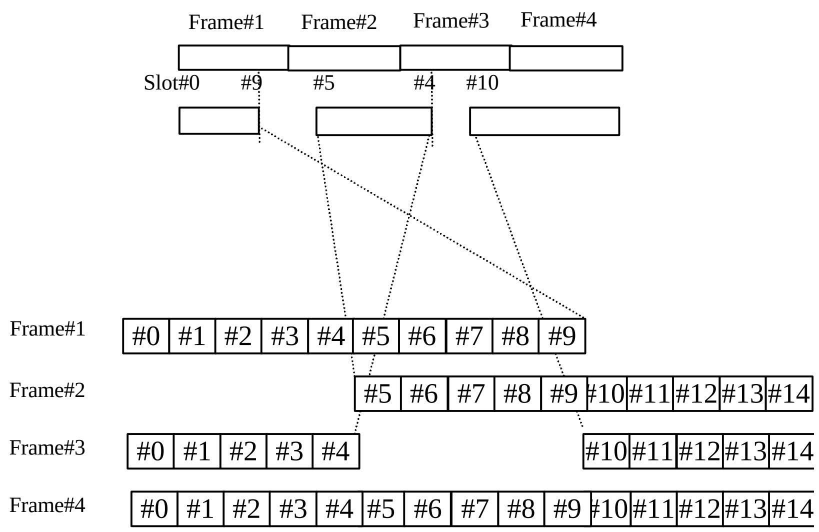

Figure 4. Cell search pattern with TGL1=10, TGL2=5, TGD=25/15 for FDD-FDD interfrequency handover.

In this way it is possible to capture higher number of SCH symbols, as shown by table 5. It shows that 13 or 11 SCH symbols can be captured, depending on the $T_{switching}$ value. This is actually higher number than what can be achieved by two 7 slot gaps and SF/2 method, so it should allow good enough performance for cell search.

Method	TGL1 (slots)	TGL2 (slots)	$T_{switching}$ (slots)	No of SCH symbols captured
puncturing	10	5	1	10-1+5-1= 13
	10	5	2	10-2+5-2= 11

Table 5. Number of SCH symbols captured with puncturing method with new proposed parameterisation.

4. Proposal

In order to allow FDD-FDD interfrequency handover measurements also with puncturing method, a CR has been prepared for TS 25.215. In the attached CR two new things are proposed:

- There can be two different length transmission gaps per TGP: TGL1 and TGL2.
- TGL1=10, TGL2=5 combination is supported for FDD-FDD interfrequency handover measurements

In addition to this, it is clarified in the CR that:

- TGP parameter is defined as number of slots, not as number of frames. This assumption has already been used earlier, e.g. in [1] and [2], and in the parameter patterns tables, that used to be in the annex of TS 25.215. However, it has not been corrected to the specifications.

REFERENCES

[1] TSGR1#7(99)b98, "Compressed Mode for FDD-FDD Handover preparation", source Mitsubishi Electric.

[2] TSGR1#8(99)e95, "Evaluation of cell search in the compressed mode", source Mitsubishi Electric.

[3] TSGR1#8(99)g76, "Acquisition Performance in Compressed Mode for UTRA-FDD", source Texas Instruments

[4] TSGR1#7(99)b27, "Use of multiple scrambling codes in compressed mode", source Ericsson.

[5] TSGR1#9(99)j03, "Means for compressed mode by puncturing in downlink", source Nokia.

[6] 3GPP RAN TS 25.215 Physical layer measurements (FDD)

3GPP TSG RAN WG1 Meeting #10
Beijing, China, Jan 18 – 21, 2000

Document R1-99-0019
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.

25.215 CR 022 Current Version: 3.1.0

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

For submission to: TSG-RAN #7 for approval [X] for information [ ] strategic [ ] non-strategic [ ] *(for SMG use only)*

list expected approval meeting # here ↑

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: Nokia **Date:** 2000-01-07

Subject: Compressed mode parameterisation for FDD-FDD interfrequency handover

Work item:

Category: *(only one category shall be marked with an X)*

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

Release:

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

Reason for change: With the present parameterisation of the compressed mode, a good synchronisation performance in FDD-FDD interfrequency handover is possible only with two compressed mode methods: reducing SF by 2 and higher layer scheduling. In order to ensure good synchronisation perfomance for FDD-FDD interfrequency handover also with compressed mode by puncturing, a modification to the parameters is needed. The needed modification is that there can be two different length transmission gaps per TGP: TGL1 and TGL2.

Clauses affected: 6.1.1.2 Parameterisation of the compressed mode

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:

help.doc

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

5.2.8 UTRAN GPS Timing of Cell Frames for LCS

Definition	The timing between cell j and GPS Time Of Week. $T_{UTRAN\text{-}GPSj}$ is defined as the time of occurrence of a specified UTRAN event according to GPS time. The specified UTRAN event is the beginning of a particular frame (identified through its SFN) in the first significant multipath of the cell j CPICH, where cell j is a cell within the active set.
Applicable for	Connected Intra, Connected Inter
Range/mapping	The resolution of $T_{UTRAN\text{-}GPSj}$ is 1µS. The range is from 0 to 6.04×10^{11} µS.

6 Measurements for UTRA FDD

6.1 UE measurements

6.1.1 Compressed mode

6.1.1.1 Use of compressed mode/dual receiver for monitoring

A UE shall, on upper layers commands, monitor cells on other frequencies (FDD, TDD, GSM). To allow the UE to perform measurements, upper layers shall command that the UE enters in compressed mode, depending on the UE capabilities.

In case of compressed mode decision, UTRAN shall communicate to the UE the parameters of the compressed mode, described in reference [2], 25.212.

A UE with a single receiver shall support downlink compressed mode.

Every UE shall support uplink compressed mode, when monitoring frequencies which are close to the uplink transmission frequency (i.e. frequencies in the TDD or GSM 1800/1900 bands).

All fixed-duplex UE shall support both downlink and uplink compressed mode to allow inter-frequency handover within FDD and inter-mode handover from FDD to TDD.

< WG1's note : the use of uplink compressed mode for single receiver UE when monitoring frequencies outside TDD and GSM 1800/1900 bands is for further study >

UE with dual receivers can perform independent measurements, with the use of a "monitoring branch" receiver, that can operate independently from the UTRA FDD receiver branch. Such UE do not need to support downlink compressed mode.

The UE shall support one single measurement purpose within one compressed mode transmission gap. The measurement purpose of the gap is signalled by upper layers.

The following section provides rules to parametrise the compressed mode.

6.1.1.2 Parameterisation of the compressed mode

In response to a request from upper layers, the UTRAN shall signal to the UE the compressed mode parameters.

The following parameters characterize a transmission gap :

- TGL : Transmission Gap Length is the duration of no transmission, expressed in number of slots.
- SFN : The system frame number when the transmission gap starts
- SN : The slot number when the transmission gap starts

With this definition, it is possible to have a flexible position of the transmission gap in the frame, as defined in [2].

The following parameters characterize a compressed mode pattern :

- TGP : Transmission Gap Period is the period of repetition of a set of consecutive frames containing up to 2 transmission gaps (*).
- TGL : As defined above (**).
- TGD : Transmission Gap Distance is the duration of transmission between two consecutive transmission gaps within a transmission gap period, expressed in number of ~~frames~~ slots. In case there is only one transmission gap in the transmission gap period, this parameter shall be set to zero.
- PD: Pattern duration is the total time of all TGPs expressed in number of frames.
- SFN : The system frame number when the first transmission gap starts
- UL/DL compressed mode selection: This parameter specifies whether compressed mode is used in UL only, DL only or both UL and DL.
- Compressed mode method: The method for generating the downlink compressed mode gap can be puncturing, reducing the spreading factor or upper layer scheduling and is described in [2].
- Transmit gap position mode: The gap position can be fixed or adjustable. This is defined in [2].
- Downlink frame type: This parameter defines if frame structure type 'A' or 'B' shall be used in downlink compressed mode. This is defined in [2].
- Scrambling code change: This parameter indicates whether the alternative scrambling code is used for compressed mode method 'SF/2'. Alternative scrambling codes are described in [3].
- PCM: Power Control Mode specifies the uplink power control algorithm applied during recovery period after each transmission gap in compressed mode. PCM can take 2 values (0 or 1). The different power control modes are described in [4].
- PRM: Power Resume Mode selects the uplink power control method to calculate the initial transmit power after the gap. PRM can take two values (0 or 1) and is described in [4].

In a compressed mode pattern, the first transmission gap starts in the first frame of the pattern. The gaps have a fixed position in the frames, and start in the slot position defined in [2].

(*) : ~~Optionally, t~~The set of parameters may contain 2 values TGP1 and TGP2, where TGP1 is used for the 1st and the consecutive odd gap periods and TGP2 is used for the even ones. ~~Note i~~If TGP1=TGP2 this is equivalent to using only one TGP value.

(**) : The set of parameters may contain 2 values TGL1 and TGL2, where TGL1 is the length of the 1st gap in TGP and TGL2 is the length of the 2nd gap in TGP. If TGL1=TGL2 this is equivalent to using only one TGL value.

In all cases, upper layers has control of individual UE parameters. The repetition of any pattern can be stopped on upper layers command.

The UE shall support [8] simultaneous compressed mode patterns which can be used for different measurements.
Upper layers will ensure that the compressed mode gaps do not overlap and are not scheduled within the same frame.
Patterns causing an overlap or too long gaps will not be processed by the UE and interpreted as a faulty message.

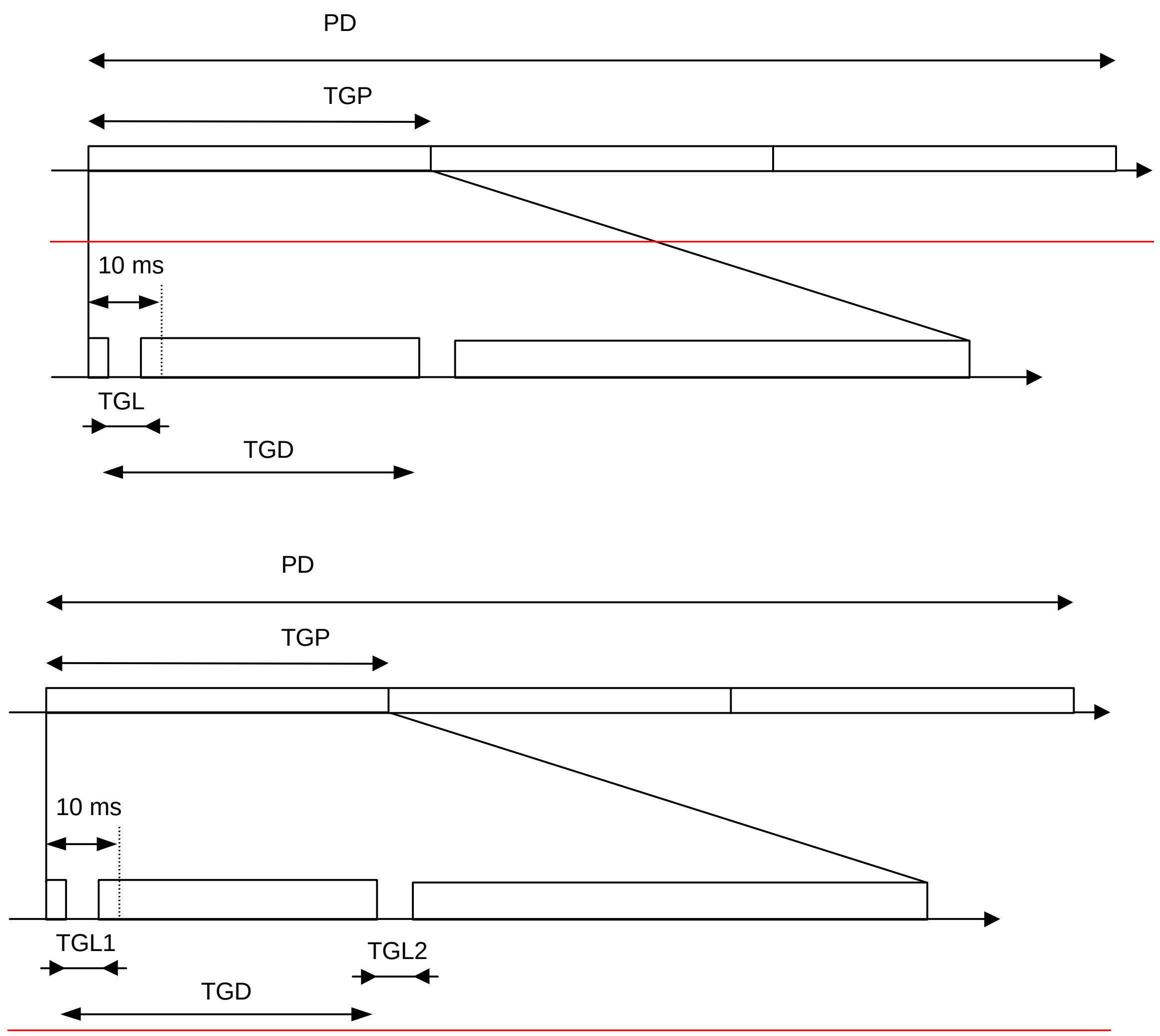

Figure 1 : illustration of compressed mode pattern parameters

6.1.1.3 Parameterisation limitations

In the table below the supported values for the TGL parameter is shown.

Measurements performed on	Supported TGL values, when TGL1=TGL2	Supported TGL values, when TGL1 ≠ TGL2; (TGL1, TGL2)
FDD inter-frequency cell	7, 14	(10, 5)
TDD cell	4	-
GSM cell	3, 4, 7, 10, 14	-

Multi-mode terminals shall support the union of TGL values for the supported modes.

Further limitations on transmission gap position is given in TS 25.212.

~~Compressed mode patterns for handover monitoring are recommended in "Annex A: Measurements for Handover~~