3G TR 25.xxx V0.0.0 (2000-09)

Technical Report

3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
Terminal Power Saving Features
(Release 2000)

Keywords
<keyword[, keyword]>

3GPP

Postal address

3GPP support office address
650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet
http://www.3gpp.org

Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document is the Technical Report of the Release 2000 work item “Terminal Power Saving Feature”.

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 25.211 (V3.2.0): "Example 1, using sequence field".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply.

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

3.2 Symbols

3.3 Abbreviations

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

CFN	Connection Frame Number
DPCCH	Dedicated Physical Control Channel
DPCH	Dedicated Physical Channel
DSCH	Downlink Shared Channel
PDSCH	Physical Downlink Shared Channel

4 Background and Introduction

Battery life is an important resource in UE side but there’s few explicit feature dedicated to UE battery saving in Release 99 specification. In order to enhance the UE battery life with respect to Release 99, terminal power saving feature is under discussion for in Release 2000 work item. In this technical report, the requirements and detail solutions are described.

5 Requirements to the Solution

This section describes the requirements to the solution of terminal power saving feature. It includes the level of changes and expected gains with respect to Release 99.

5.1 Level of Changes with respect to Release 99

5.1.1 Gated DPCCH Transmission

Detail parameters and procedure of gated DPCCH transmission is covered in subclause 6.1.

5.1.1.1 Required Changes in UE

US should have a capability of generating gating patterns for uplink and downlink and power control should be operated based on the gating pattern. UE should be able to determine the indication of initiation and termination of gating.

5.1.1.2 Required Changes in Node B

Node B should be able to generate gating patterns for uplink and downlink and power control should be operated based on the gating pattern.

5.2 Expected Gain with respect to Release 99

In Release 99, UE battery life was not considered explicitly as a requirement to the specification. With the terminal power saving features, UE battery life can be extended with respect to Release 99 and the interference can also be reduced by the reduced transmission power in uplink and/or downlink.

6 Terminal Power Saving Features

In this section, the solutions for the terminal power saving features are described.

6.1 Gated DPCCH Transmission Scheme

Gated DPCCH transmission is one of terminal power saving features where transmitter switches off its transmission intermittently when there is no DTCH data on both uplink and downlink. The main impact by the gated DPCCH transmission is reduced power control rate but there are advantages such as terminal power saving, uplink and downlink interference reduction. Gated DPCCH transmission can be applied only when the UE is in Cell-DCH state with DSCH, and it can be initiated and terminated at the time directed by higher layer.

6.1.1 Related Parameters

When the call is setup, UTRAN and UE negotiate the gating capability and parameters. The parameters controlling the gating operation are:

Table 1. Gating Parameters

Gating Rate	1	1/3	1/5

Gating Pattern	Random	Regular

Gating Mode	Downlink Only	Uplink and Downlink

6.1.2 Transmitter and Receiver Operations

UTRAN and UE shall have the knowledge of the gating pattern for the received signal as well as that for the transmission, so that they can synchronize their reception/transmission to each other according to the gating pattern. During gated DPCCH transmission, reduced power control rate shall be maintained even when DCCH is transmitted through DPDCH. The operations of transmitter and receiver during gated DPCCH transmission behave differently depending on the existence of DPDCH which carrying DCCH.

When the DPCH consists of only DPCCH, then the transmitter shall switch-on its transmission only for the specified time slots to reduce the transmission rate of Pilot, TPC, TFCI, and FBI (uplink only). Other than the specified time slots, transmission of DPCH shall be switched-off.

When the DPCH consists of both DPDCH and DPCCH, then the transmitter shall switch-on its transmission all the time slots. In the receiver, however, the TPC fields which were transmitted only in the time slots specified shall be considered to be valid to maintain the reduced power control rate.

6.1.3 Initiation and Termination Indication of Gated DPCCH Transmission

The gated DPCCH transmission can be initiated either by UE's request to UTRAN followed by UTRAN's permission or by the UTRAN’s command to UE. In either case, the UTRAN determines whether gated DPCCH transmission is initiated or not. Similarly, gated DPCCH transmission can be terminated by UE's request followed by UTRAN's permission or by UTRAN's notice to UE. UTRAN indicates the initiation and termination of gated DPCCH transmission by transmitting specific TFCI that is known to both UTRAN and UE.

6.1.4 Operation Mode of Gated DPCCH Transmission

6.1.4.1 Uplink and Downlink

In this mode, the gated DPCCH transmission is applied to both uplink and downlink with the gating pattern specified in subclause 6.1.5.

6.1.4.2 Downlink Only

In this mode, the gated DPCCH transmission is applied only to the downlink with the gating pattern specified in subclause 6.1.5. The advantage of this mode is downlink interference reduction.

6.1.5 Switch-On/Off Pattern

6.1.5.1 DPCCH only Transmission

When the DPCH consists of DPCCH only, the transmitter switch-on its transmission only in the time slots specified in tables 2 and 3 for downlink and uplink, respectively. In the tables the CFN of the radio frame is denoted by i, and the range of the gating group number j defined in subclause 6.1.5.3 is j = 0, 1, 2, 3, 4 for gating rate 1/3, and j = 0, 1, 2 for gating rate 1/5. The function $s(i,j)$ used for the reference pattern is defined in subclause 6.1.5.3.

Table 2. Switched-on Time Slots for downlink DPCCH.

Gating pattern	Gating rate	Switched-on Time Slots for downlink DPCCH fields	
		Pilot	TPC, TFCI
None	1	All slots (0, 1, …, 14)	All slots (0, 1, …, 14)
Regular	1/3	$j \times 3$	$1 + j \times 3$
	1/5	$1 + j \times 5$	$2 + j \times 5$
Random	1/3	$j \times 3 + s(i,j) - 1$	$j \times 3 + s(i,j)$
	1/5	$j \times 5 + s(i,j) - 1$	$j \times 5 + s(i,j)$

Table 3. Switched-on Time Slots for uplink DPCCH.

Gating pattern	Gating rate	Switched-on Time Slots for uplink DPCCH fields
		Pilot, TFCI, FBI, TPC
None	1	All slots (0, 1, …, 14)
Regular		
	1/3	$2 + j \times 5$
	1/5	$4 + j \times 5$
Random	1/3	$j \times 3 + s(i,j)$
	1/5	$j \times 5 + s(i,j)$

6.1.5.2 DPDCH and DPCCH Transmission

When the DPCH consists of DPDCH and DPCCH, then the transmitter shall switch-on its transmission in all the time slots.

6.1.5.3 Reference Pattern

15 slots of the radio frame are divided into *N* gating groups, each group consists of *S* consecutive slots. For gating rate 1/3, $N = 5$ and $S = 3$, and for gating rate 1/5, $N = 3$ and $S = 5$. Denote the CFN of the current radio frame by *i*, $i = 0, 1, 2, \ldots, 255$. Further define the 19 bit sequence $(a_{18}, a_{17}, \ldots, a_0) = (1, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1)$.

Table 4. Summary of Reference Pattern *s(I, j)*

Parameter	Value	
CFN	0, 1, …, 255 (8bits)	
$a_{18}, a_{17}, \ldots, a_0$	1, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1	
gating rate	1/3	1/5
Number of gating group (*N*)	5	3
Gating group size (*S*)	3	5

For CFN *i*, $i = 0, 1, 2, \ldots, 255$, concatenated CFN $C_i = i + 256 \times i$, and gating group *j*, the function $s(i, j)$ is defined as

$$s(i,j) = \begin{Bmatrix} (A_j \oplus C_i)_{10} \bmod (S-1) + 1, & j = 0 \\ (A_j \oplus C_i)_{10} \bmod S, & j = 1,\ldots,N-2 \\ S-1, & j = N-1 \end{Bmatrix}, \quad i = 0,1,\ldots,255$$

where $(X)_{10}$ represents the decimal representation of the number *X*, and $X \oplus Y$ denotes bit-wise modulo 2 addition of the binary representation of the numbers *X* and *Y*. And $A_j = \sum_{k=j}^{j+15} 2^{k-j} a_k$, j=0,1,...,*N*-2.

6.1.6 Detection of DPDCH frame during Gating

Since DPDCH is possibly transmitted during gating period, the receiver has to determine if the DPDCH is transmitted or not. One possible solution is the pilot energy comparison. Pilot energy in the time slots that do not contain pilot during gating is compared to pilot energy in those slots that contains pilot during gating. If this is above threshold and the decoded TFCI is not the specific codeword indicating termination of gating, the receiver considers the DPDCH is transmitted in the frame.

6.1.7 Power Control

6.1.7.1 Power Control Parameters

- In this subclause, the power control parameters during and after the gated DPCCH transmission.DPC_MODE 0

  In DPC_MODE 0, if gated DPCCH transmission is not initiated, the UE sends a unique TPC command in each slot and the TPC command generated is transmitted in the first available TPC field in the uplink DPCCH.

  During gated DPCCH transmission, both of the transmit time slot and receive time slot in uplink and downlink are not continuous. UE sends a unique TPC command in each switch-on transmit time slot and the TPC command generated based on the switch-on receive time slot is transmitted in the first available TPC field in the uplink DPCCH.

- DPC_MODE 1

  In DPC_MODE 1, if gated DPCCH transmission is not initiated, the UE repeats the same TPC command over 3 slots and the new TPC command is transmitted such that there is a new command at the beginning of the frame.

  During gated DPCCH transmission, DPC_MODE 1 cannot be used because the transmission of DPCCH field is not continuous. One possible solution is that during gating, DPC_MODE 0 is used instead of DPC_MODE 1 without explicit signaling.

- Algorithm 1

  In Algorithm 1, if gated DPCCH transmission is not initiated, UE shall derive a TPC_cmd based on the TPC command(s) received in each slot.

  During gated DPCCH transmission, the UE derives a unique TPC command in each switch-on downlink time slot and adjust its transmission power in the first available switch-on transmit time slot.

- Algorithm 2

  In Algorithm 2, if gated DPCCH transmission is not initiated, UE shall process received TPC commands on a 5-slot cycle. It emulates smaller step sizes than the minimum power control step specified in subclause 5.1.2.2.1, or to turn off uplink power control by transmitting an alternating series of TPC commands.

  During gated DPCCH transmission, Algorithm 2 cannot be used because the downlink transmission of DPCCH field is not continuous. One possible solution is that during gating, Algorithm 1 is used instead of Algorithm 2 without explicit signaling.

- Recovery period

  During gated DPCCH transmission, the power control rate is reduced by the amount of gating rate. In order to compensate the effect of reduced power control rate during gating, power control recovery period is used similarly to compressed mode.

- Power control step

  During gated DPCCH transmission, power control step can be different from non-gating mode in order to compensate the reduced power control rate.

6.1.7.2 Power Control Procedure

In this subclause, the power control procedure is described.

6.1.7.2.1 Uplink and Downlink Gated DPCCH Transmission

In the case that the gated DPCCH transmission is enabled for both uplink and downlink, the power control operations are as follows.

Uplink transmit power adjustment

UE shall adjust the transmit power in switched-on time slot in response to the latest valid downlink TPC. The change in uplink transmit power shall take place immediately before the start of the pilot field on the uplink DPCCH.

Uplink TPC generation and transmission

UE shall generate the uplink TPC based on the latest valid downlink switched-on time slot, and shall transmit the TPC on the next valid uplink switched-on time slot

Downlink transmit power adjustment

UTRAN shall adjust the transmit power in switched-on time slot in response to the latest valid uplink TPC. The change in downlink transmit power shall take place immediately before the start of the pilot field on the downlink DPCCH

Downlink TPC generation and transmission

UTRAN shall generate the downlink TPC based on the latest valid uplink switched-on time slot, and shall transmit the TPC on the next valid downlink switched-on time slot

6.1.7.2.2 Downlink Only Gated DPCCH Transmission

In the case that the gated DPCCH transmission is enabled only for the downlink, then the power control operations are as follows.

Uplink transmit power adjustment

UE shall adjust the transmit power in response to the downlink TPC received in the valid downlink switched-on time slot. And the uplink transmit power shall remain constant until next valid downlink TPC is received. The change in uplink transmit power shall take place immediately before the start of the pilot field on the uplink time slot.

Uplink TPC generation and transmission

UE shall generate and transmit an uplink TPC based on the valid downlink switched-on time slot. And the UE shall transmit the TPC repeatedly before receiving the next valid downlink switched-on time slot.

Downlink transmit power adjustment

UTRAN shall adjust the transmit power in switched-on time slot in response to the repeated uplink TPC(s) which are known to be the same. The change in downlink transmit power shall take place immediately before the start of the pilot field on the switched-on downlink time slot

Downlink TPC generation and transmission

UTRAN shall generate and transmit downlink TPC based on the uplink time slot(s) whose transmit power is known to be the same.

6.1.8 Operation with other Features

In this subclause, the required changes in operation of other features such as frame synchronisation confirmation, transmit diversity, compressed mode, and soft handover when they are used with gated DPCCH transmission.

6.1.8.1 Frame Synchronisation

Frame synchronisation confirmation with the dedicated pilot pattern shall not be done during gated DPCCH transmission. It is because parts of dedicated pilot bits in a frame may not be transmitted during switched-off period.

6.1.8.2 Transmit diversity

6.1.8.2.1 Open Loop Transmit Diversity

Since STTD encoding is performed for each time slot unit, there's no impact by gated DPCCH transmission.

6.1.8.2.2 Closed Loop Transmit Diversity

When the gated DPCCH transmission is turned on during closed loop transmit diversity, gating impacts uplink feedback signaling. For closed loop transmit diversity Mode 1, it will work without changes. For closed loop transmit diversity Mode 2, one possible solution is that during gating, Mode 1 is used instead of Mode 2 without explicit signaling. If the Mode 1 is used instead of Mode 2 during gated DPCCH transmission, the Tx diversity mode should be return to Mode 1 without explicit signaling when the gated DPCCH transmission is terminated.

6.1.8.3 Compressed mode

If the compressed mode is initiated during gated DPCCH transmission, it shall be disabled.

6.1.8.4 Soft Handover

If all of the Node Bs in the Active set do not support gated transmission at the same time, gated DPCCH transmission shall be disabled.

7 Impacts to other WGs

In this subclause, the impacts to other WGs by each solution for terminal power saving features are listed.

7.1 Gated DPCCH Transmission Scheme

7.1.1 WG2

TS 25.301

TS 25.302

TS 25.331

7.1.2 WG3

TS 25.423

TS 25.433

7.1.3 WG4

TS 25.101

8 Performance

<Note: This section will be covered in separate Tdoc.>

8.1 Gated DPCCH Transmission Scheme

8.1.1 Simulation Parameters and Assumptions

8.1.2 Results

9 Backward Compatibility

A UE based on Release 99 can be used in Release 2000 UTRAN with gated DPCCH transmission capability without any impact because the gating capability is negotiated during call-setup. Similarly, a UE based on Release 2000 with gated DPCCH transmission capability can be used in Release 99 UTRAN without any impact by the same reason. Consequently, the backward compatibility is guaranteed with gated DPCCH transmission in Release 2000.

History

Document history		
Date	**Version**	**Comment**
	0.0.0	

Editor for 3G TR xx.xxx is:

Tel. :
Fax :
Email :

This document is written in Microsoft Word version.

Annex <X>:
Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**