TSG-RAN Working Group 1 meeting #12
Seoul, Korea
April 10 – 13, 2000

TSGR1#12(00)0522

Agenda item:

Source: Ericsson

Title: CR 25.214-090: Level of specification of downlink power control

Document for: Decision

In UTRAN, the RNC is responsible for radio resource management. This means that the RNC need to have some basic understanding about how the Node Bs behave. It is very difficult for the RNC to control the downlink power resource, if too much flexibility exist for the Node B "to do whatever it wants".

Up to now, the Node B downlink power behaviour has been very loosely specified. For example, a Node B may completely disregard the TPC commands it receives on the uplink.

In a multi-vendor scenario, interoperability problems may occur due to the Node B flexibility. With the current specifications, one Node B may decide to follow the uplink TPC commands (within maximum and minimum power limits), while another Node B may decide to transmit constantly at maximum allowed power. The effects of such a behaviour, e.g. in a soft handover scenario are difficult to estimate. However, it is clear that the RNC will have very little control over the resource usage in the downlink.

It seems important to specify that the Node B shall follow the uplink TPC commands to avoid the situation above. Furthermore, if this is specified it makes no sense to leave open the possibility to employ multiples of the minimum step size as the power control step. Hence, Node B shall use the power control step assigned by the RNC.

The proposed changes are introduced to TS 25.214 with the attached CR.

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3GPP TSG RAN WG1 Meeting #12
Seoul, Korea, April 10 – 13, 2000

Document ????99???
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.

25.214	CR	090	Current Version:	3.2.0

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

For submission to:	TSG-RAN #8	for approval	X	strategic		(for SMG use only)
list expected approval meeting # here ↑		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: *(at least one should be marked with an X)*

(U)SIM		ME	X	UTRAN / Radio	X	Core Network	

Source: Ericsson **Date:** 2000-03-30

Subject: Level of specification of downlink power control

Work item:

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

F	Correction		**Release:**	Phase 2	
A	Corresponds to a correction in an earlier release			Release 96	
B	Addition of feature			Release 97	
C	Functional modification of feature	X		Release 98	
D	Editorial modification			Release 99	X
				Release 00	

Reason for change:

Node B behaviour needs to be specified to ensure interoperability. This is done by specifying Node B's response to TPC commands. Changes:

- How DL power shall be updated is specified in 5.2.1.2. The calculation includes both inner loop and power balancing loop behaviour.
- The power control step size is defined to be 0.5 or 1 dB (no longer minimum step size).
- In case of congestion the TPC commands from the UE may be ignored.
- The UE shall not make any assumption about the downlink power.
- For compressed mode similar changes in 5.2.1.3 (through referencing).
- Clarifications to Annex B.3, to make sure the same terminology is used in WG3 and WG1 specifications, and the same terminology is used in 5.2.1.2 and Annex B.3.
- Editorial changes to 5.2.1.2 and Annex B.1.

Clauses affected: 5.2.1.2, 5.2.1.3, B.1, B.3

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:

5.2 Downlink power control

The transmit power of the downlink channels is determined by the network. In general the ratio of the transmit power between different downlink channels is not specified and may change with time. However, regulations exist as described in the following subclauses.

5.2.1 DPCCH/DPDCH

5.2.1.1 General

The downlink transmit power control procedure controls simultaneously the power of a DPCCH and its corresponding DPDCHs. The power control loop adjusts the power of the DPCCH and DPDCHs with the same amount, i.e. the relative power difference between the DPCCH and DPDCHs is not changed.

The relative transmit power offset between DPCCH fields and DPDCHs is determined by the network The TFCI, TPC and pilot fields of the DPCCH are offset relative to the DPDCHs power by PO1, PO2 and PO3 dB respectively. The power offsets may vary in time.

5.2.1.2 Ordinary transmit power control

The UE shall generate TPC commands to control the network transmit power and send them in the TPC field of the uplink DPCCH. An example on how to derive the TPC commands in given in Annex B.2.

When the UE is not in soft handover the TPC command generated is transmitted in the first available TPC field in the uplink DPCCH.

When the UE is in soft handover it should check the downlink power control mode (DPC_MODE) before generating the TPC command:

- if DPC_MODE = 0 : 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;
- if DPC_MODE = 1 : 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.

The DPC_MODE parameter is a UE specific parameter controlled by the UTRAN.

Upon receiving the TPC commands UTRAN shall adjust its downlink DPCCH/DPDCH power accordingly. For DPC_MODE = 0, UTRAN shall estimate the transmitted TPC command TPC_{est} to be 0 or 1, and shall update the power every slot. If DPC_MODE = 1, UTRAN shall estimate the transmitted TPC command TPC_{est} over three slots to be 0 or 1, and shall update the power every three slots.

After estimating the TPC command, UTRAN shall adjust the current downlink power P_{curr} [dB] to a new power P_{new} [dB] according to the following formula:

$P_{new} = P_{curr} + P_{TPC} + P_{bal}$,

where P_{TPC} is the power adjustment due to the inner loop power control with

$$P_{TPC} = \begin{cases} +\Ä_{TPC} & \text{if } TPC_{est} = 1 \\ -\Ä_{TPC} & \text{if } TPC_{est} = 0 \end{cases}$$, [dB]

and P_{bal} [dB] is a correction according to the downlink power control procedure for balancing radio link powers towards a common reference power. The power balancing procedure and control of the procedure is described in TS 25.433, and an example of how P_{bal} can be calculated is given in Annex B.3.

The power step size Δ_{TPC} can take two values: 1 dB or 0.5 dB. It is mandatory for UTRAN to support Δ_{TPC} of 1 dB, while support of 0.5 dB is optional.

In case of congestion (commanded power not available), UTRAN may disregard the TPC commands from the UE. ~~As a response to the received TPC commands, UTRAN may adjust the downlink DPCCH/DPDCH power.~~ The average power of transmitted DPDCH symbols over one timeslot shall not exceed Maximum_DL_Power (dBm), nor shall it be below Minimum_DL_Power (dBm). Transmitted DPDCH symbol means here a complex QPSK symbol before spreading which does not contain DTX. Maximum_DL_Power and Minimum_DL_Power are power limits for one ~~spreading~~ channelisation code.

~~Changes of power shall be a multiple of the minimum step size $\Delta_{TPC,min}$ dB. It is mandatory for UTRAN to support $\Delta_{TPC,min}$ of 1 dB, while support of 0.5 dB is optional.~~

UTRAN may further employ the following method. If the value of *Limited Power Raise Used* parameter is 'Used', UTRAN shall not increase the DL power of the radio link~~RL~~ if it would exceed by more than *Power_Raise_Limit* dB the averaged DL power used in the last *DL_Power_Averaging_Window_Size* ~~time~~slots of the same radio link~~RL~~. This shall only be applied after the first *DL_Power_Averaging_Window_Size* ~~time~~slots after the activation of this method.

Power_Raise_Limit and *DL_Power_Averaging_Window_Size* are parameters configured in the UTRAN.

The UE shall not make any assumptions on how the downlink power is set by UTRAN.

When TPC commands cannot be generated in the UE due to downlink out-of-synchronisation, the TPC command transmitted shall be set as "1" during the period of out-of-synchronisation.

5.2.1.3 Power control in compressed mode

The aim of downlink power control in uplink or/and downlink compressed mode is to recover as fast as possible a signal-to-interference ratio (SIR) close to the target SIR after each transmission gap.

The UE and UTRAN behaviour is the same in compressed mode as in normal mode, described in subclause 5.2.1.2.

~~The UTRAN behaviour during compressed mode is not specified. As an example, the algorithm can be similar to uplink power control in downlink compressed mode as described in subclause 5.1.2.3.~~

In downlink compressed mode or in simultaneous downlink and uplink compressed mode, the transmission of downlink DPCCH and DPDCH(s) is stopped.

Annex B (Informative): Downlink power control

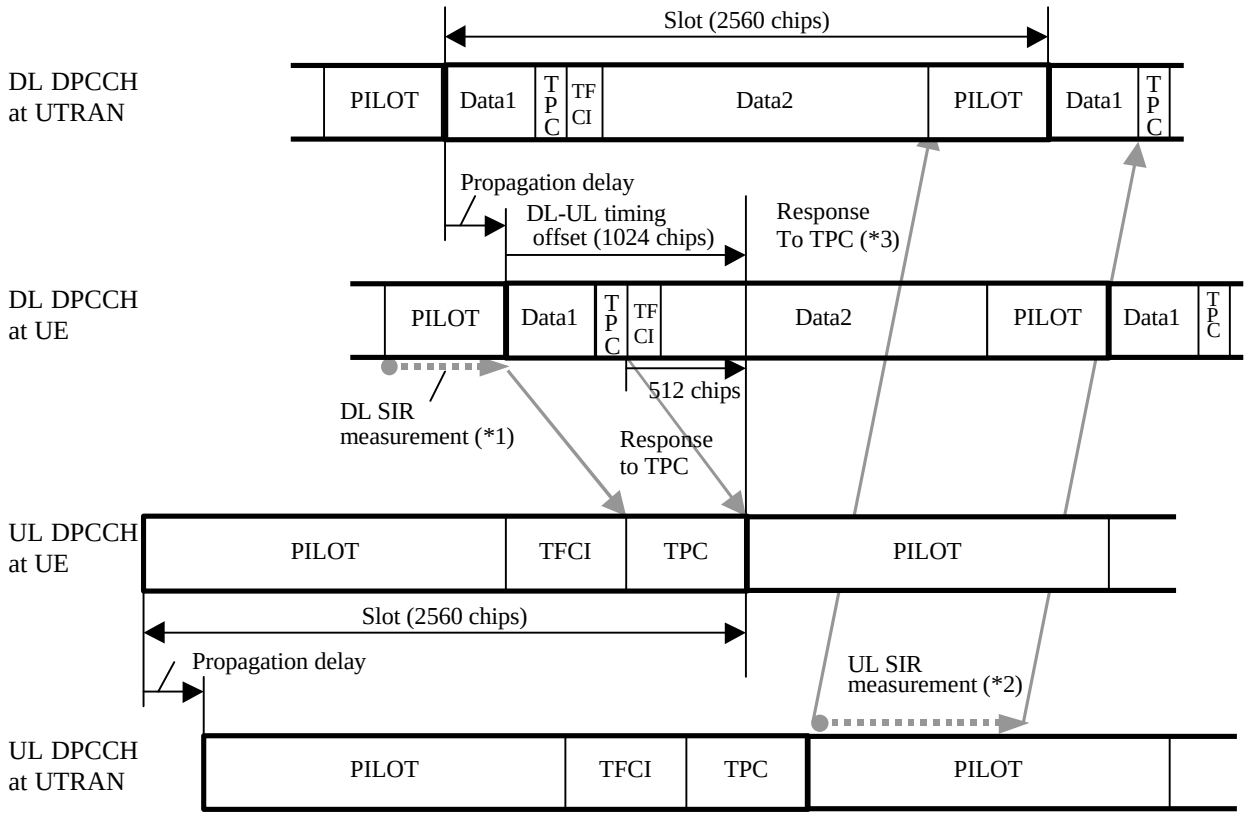
B.1 Power control timing

The power control timing described in this annex should be seen as an example on how the control bits have to be placed in order to permit a short TPC delay.

In order to maximise the cell radius distance within which one-slot control delay is achieved, the frame timing of an uplink DPCH is delayed by 1024 chips from that of the corresponding downlink DPCH measured at the UE antenna.

Responding to a downlink TPC command, the UE shall change its uplink DPCH output power at the beginning of the first uplink pilot field after the TPC command reception. Responding to an uplink TPC command, the UTRAN access point shall change its DPCH output power at the beginning of the next downlink pilot field after the reception of the whole TPC command. Note that in soft handover, the TPC command is sent over one slot when DPC_MODE is 0 and over three slots when DPC_MODE is 1. Note also that the delay from the uplink TPC command reception to the power change timing is not specified for UTRAN. The UE shall decide and send TPC commands on the uplink based on the downlink SIR measurement. The TPC command field on the uplink starts, when measured at the UE antenna, 512 chips after the end of the downlink pilot field. The UTRAN access point shall decide and send TPC commands based on the uplink SIR measurement. However, the SIR measurement periods are not specified either for UE nor UTRAN.

Figure B.1 illustrates an example of transmitter power control timings.



*1,2 The SIR measurement periods illustrated here are examples. Other ways of measurement are allowed to achieve accurate SIR estimation.

*3 If there is not enough time for UTRAN to respond to the TPC, the action can be delayed until the next slot.

Figure B.1: Transmitter power control timing

B.2 Example of implementation in the UE

The downlink inner-loop power control adjusts the network transmit power in order to keep the received downlink SIR at a given SIR target, SIR_{target}. A higher layer outer loop adjusts SIR_{target} independently for each connection.

The UE should estimate the received downlink DPCCH/DPDCH power of the connection to be power controlled. Simultaneously, the UE should estimate the received interference. The obtained SIR estimate SIR_{est} is then used by the UE to generate TPC commands according to the following rule: if $SIR_{est} > SIR_{target}$ then the TPC command to transmit is "0", requesting a transmit power decrease, while if $SIR_{est} < SIR_{target}$ then the TPC command to transmit is "1", requesting a transmit power increase.

B.3 Radio link power balancing~~Adjustment loop~~

In case of soft handover, UTRAN may employ downlink radio link power balancing, that tries to balance the radio link powers towards reference power. An example of a power balancing adjustment loop is given below.

The UTRAN access point radio link transmission power is adjusted by the the power balancing term P_{bal} [dB]~~, in which they change their calculated transmission powers *P(i)*~~ which is calculated~~in every slot~~ according to the following equation:

~~- P(i+1) = P(i) + S_{INNER}(i) + S_{ADJ}(i);~~

- ~~S~~P_{bal}~~$_{ADJ}$~~(i) = sign{(1 – r)(P_{REF} – P_{curr}~~(i)~~)} × min{|(1 – r)(P_{REF} – P_{curr}~~(i)~~)|, $PS_{bal,max}$~~$_{ADJ\_MAX}$~~};

where:

~~- *P(i)*: calculated transmission power of UTRAN access point in dBm;~~

~~- S_{INNER}*(i)*: inner loop control in dB;~~

- ~~*S*~~P_{balADJ}*(i)*: radio link power balancing~~adjustment loop~~ control in dB;
- *sign{x}*: sign function of the value *x*, i.e. +1 when x>0, 0 when x=0, and –1 when x<0;
- *r*: convergence coefficient ($0 \le r \le 1$);
- P_{REF}: reference transmission power in dBm;
- ~~*S*~~$P_{bal,max}$~~$_{ADJ\_MAX}$~~: maximum power change limit for radio link power balancing control~~by adjustment loop~~ in dB.

The actual transmission power level shall be a value which is the nearest allowed power level to P_{curr}~~*P(i)*~~. The parameters~~, *r*,~~ P_{REF}, and $P_{bal,max}$~~S_{ADJ_MAX}~~ are~~shall be~~ signalled by higher layers. $P_{bal,max}$~~S_{ADJ_MAX}~~ shall be a multiple of the ~~minimum~~power control step size Δ_{TPC}~~$_{,min}$~~ dB.