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To: TSG RAN WG1
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1 Summary

Power control is applied for the TDD mode to limit the interference level within the system thus reducing the intercell interference level and to reduce the power consumption in the UE. This document describes the transmit power control procedure for 1.28Mcps TDD.

In 1.28Mcps TDD, for uplink, the power control of the DPCH is closed loop transmitter power control. For the downlink the transmit power control adjustment of the S-CCPCH (for FACH) can be calculated according the transmit power level signalled in the RACH.

While in 3.84Mcps TDD, for uplink, the power control of the P-RACH and DPCH are open loop transmit power control.

2 Proposal

In order to make the power control procedure of 1.28Mcps option clear, it’s proposed to discuss and include the following text proposal into the clause 5.1 Transmitter Power Control of working CR of TS25.224.

---------------------------------- Changes to working CR of 25.224 begin ------------------------------

5.1 Transmit Power Control

The basic purpose of power control is to limit the interference level within the system thus reducing the intercell interference level and to reduce the power consumption in the UE.

The main characteristics of power control are summarized in the following table.

Table -11: Transmit Power Control characteristics

	Uplink	**Downlink**
Power control rate	Variable Closed loop: 0-200 cycles/sec. Open loop: (about 200us – 3575us delay)	Variable Closed loop: 0-200 cycles/sec.
Step size	1,2,3 dB (closed loop)	1,2,3 dB (closed loop)
Remarks	All figures are without processing and measurement times	Within one timeslot the powers of all active codes may be balanced to within a range of 20 dB

Note: All codes within one timeslot allocated to the same CCTrCH use the same transmission power in case they have the same Spreading Factor.

5.1.1 Uplink Control

5.1.1.1 General Limits

By means of higher layer signalling, the Maximum_Allowed_UL_TX_power for uplink may be set to a value lower than what the terminal power class is capable of. The total transmit power shall not exceed the allowed maximum. If this would be the case, then the transmit power of all uplink physical channels in a timeslot is reduced by the same amount in dB.

5.1.1.2 Open loop power control for the UpPTS

The transmit power level by a UE on the UpPTS shall be calculated based on the following equation:

$$P_{UpPTS} = L_{P\text{-}CCPCH} + PRX_{UpPTS,des}$$

where, P_{UpPTS} : transmit power level in dBm,

$L_{P\text{-}CCPCH}$: measured path loss in dB (P-CCPCH reference transmit power level is broadcast on BCH),

$PRX_{UpPTS,des}$: desired RX power level at cell's receiver in dBm, which is an average value and is broadcast on BCH.

The interference power on the UpPTS (I_{UpPTS}) measured by the Node B is reported to the RNC on a regular basis to allow the RNC to make a decision for new control parameters.

The network signals (on BCH) a power increment that is applied only for the access procedure. At each new transmission of a SYNC_UL burst during the access procedure, the transmit power level can be increased by this power increment.

5.1.1.3 Common Physical Channel

In 1.28Mcps TDD system, the F-PACH brings the answer to the SYNC_UL burst of the UE. The answer, a one burst long message, shall bring besides the acknowledgement to the received SYNC_UL burst, the timing and power level indications to prepare the transmission of the RACH burst.

The transmit power level on the PRACH is calculated by the following equation:

$$P_{PRACH} = L_{P\text{-}CCPCH} + PRX_{PRACH,des}$$

Where, P_{PRACH} is the UE transmit power level on the PRACH;

$PRX_{PRACH,des}$ is the desired receive power level on the PRACH,which is signalled by the network on the F-PACH

The network computes $PRX_{PRACH,des}$ according to the measuring the interference and the antenna gains on the PRACH timeslot which has to be averaged over an configurable (by O&M) number of frames (N).

5.1.1.4 Dedicated Physical Channel

The closed loop power control makes use of layer 1 symbol in the DPCH. The power control step can take the values 1,2,3 dB within the overall dynamic range 80dB. The initial transmission power of the uplink Dedicated Physical Channel is signalled by the UTRAN.

Closed-loop TPC is based on SIR and the TPC processing procedures are described in this section.

The node B should estimate signal-to-interference ratio SIR_{est} of the received uplink DPCH. The node B should then generate TPC commands and transmit the commands according to the following rule: if $SIR_{est} > SIR_{target}$ then the TPC command to transmit is "down", while if $SIR_{est} < SIR_{target}$ then the TPC command to transmit is "up".

At the UE, soft decision on the TPC bits is performed, and when it is judged as 'down', the mobile transmit power shall be reduced by one power control step, whereas if it is judged as 'up', the mobile transmit power shall be raised by one power control step. A higher layer outer loop adjusts the target SIR. This scheme allows quality based power control.

The closed loop power control procedure for UL DPCH is not affected by the use of TSTD.

An example of UL power control procedure for DPCH is given in Annex A.3.

5.1.1.4.1 Out of synchronization handling

When the TPC bit cannot be received due to out-of-synchronisation, the transmission power value shall be kept at a constant value. When SIR measurement cannot be performed for being out-of-synchronisation, the TPC command shall always be set to = 'up' during the period of being out-of-synchronisation.

5.1.2 Downlink Control

5.1.2.1 Common Physical Channel

The power of the P-CCPCH/PICH
The primary CCPCH/PICH transmit power is set by high layer signalling and can be changed based on network determination. The reference power of P-CCPCH is signalled on the BCCH on a periodic basis.

The power of the F-PACH
The power value for the F-PACH is set by the network.

The power of the S-CCPCH

The power of the S-CCPCH (for FACH)

It is set by the network and can take into account both the received power level on the PRACH from the addressed UE and the transmit power level as signalled by the UE.

The power of the S-CCPCH(for PCH)

This condition is the same as P-CCPCH.

5.1.2.2 Dedicated Physical Channel

The initial transmission power of the downlink Dedicated Physical Channel is set by the network until the first UL DPCH arrives. After the initial transmission, the node B transits into SIR-based closed-loop TPC.

The UE should estimate signal-to-interference ratio SIR_{est} of the received downlink DPCH. The UE should then generate TPC commands and transmit the commands according to the following rule: if $SIR_{est} > SIR_{target}$ then the TPC command to transmit is "down", while if $SIR_{est} < SIR_{target}$ then the TPC command to transmit is "up".

At the Node B, soft decision on the TPC bits is performed, and when it is judged as ‘down’, the transmission power shall be reduced by one power control step, whereas if judged as ‘up’, the transmission power shall be raised by one power control step.

When TSTD is applied, the UE can use two consequtive measurements of the received SIR in two consequtive sub-frames to generate the power control command. An example implementation of DL power control procedure for 1.28 Mcps TDD when TSTD is applied is given in Annex A.4.

5.1.2.2.1 out of synchronisation handling

When the TPC bit cannot be received due to out-of-synchronisation, the transmission power value shall be kept at a constant value.

When SIR measurement cannot be performed due to out-of-synchronisation, the TPC command shall always be = ‘up’ during the period of being out-of-synchronisation.

5.5.3.1 TSTD Transmission Scheme for P-CCPCH

A block diagram of an example of a TSTD transmitter is shown in figure [F2]. Channel coding, rate matching, interleaving, bit-to-symbol mapping, spreading, and scrambling are performed as in the non-diversity mode. Then the data is time multiplexed with the midamble sequence. Then, after pulse shaping and modulation and amplification, P-CCPCH is transmitted from antenna 1 and antenna 2 alternately every sub-frame. If there is a DPCH that uses TSTD, TSTD is also applied to P-CCPCH. An example of the antenna-switching pattern is shown in figure [F2].

A.3 Example Implementation of Closed Loop Uplink Power Control in Node B for 1.28 Mcps TDD

The measurement of received SIR shall be carried out periodically at Node B. When the measured value is higher than the target SIR value, TPC command = “down”. When the measurement is lower than or equal to the target SIR, TPC command = “up”.

In case of an uplink transmission pause on DPCH, the initial uplink transmission power of DPCH after the pause can be determined by an open loop power control. After the initial transmission after the pause, a closed loop uplink power control procedure can resume.

A.4 Example Implementation of Downlink Power Control in UE for 1.28 Mcps TDD when TSTD is used

When TSTD is applied, the UE can use the consequtive measurements of SIR to calculate SIR_{AVG}:

$$SIR_{AVG}(i) = w_1 \cdot SIR(i-1) + w_2 \cdot SIR(i),$$

where, $w_1 + w_2 = 1$, $w_1 >= 0$, $w_2 >= 0$, and SIR(i) is the measurement of SIR in sub-frame i and $SIR_{AVG}(i)$ is the measurement of SIR_{AVG} in sub-frame i. If SIR_{AVG} is greater than the target SIR value, TPC command = “down”. If the SIR_{AVG} is smaller than the target SIR value, TPC command = “up”.

In case of a downlink transmission pause on the DPCH, the example in Annex A2 can be used for DL power control with $RSCP_{virt}(i)$ and ISCP(i) replaced by $RSCP_{AVG}(i)$ and $ISCP_{AVG}(i)$, where

$$RSCP_{AVG}(i) = w_1 \cdot RSCP_{virt}(i-1) + w_2 \cdot RSCP_{virt}(i),$$

$$ISCP_{AVG}(i) = w_1 \cdot ISCP(i-1) + w_2 \cdot ISCP(i).$$

---------------------------------- Changes to working CR of 25.224 end ------------------------------