3GPP TSG RAN WG1

TSGR1#7(99)d55

Hannover, Germany

Agenda item: **Ad hoc 9**

Source: **Philips**

Title: **Text proposal for power control**

Document for: **Decision**

Introduction

This text proposal for TS25.214 is as agreed in adhoc 9 at WG1 #7, being based on [1] which described power control "Algorithm 2" as agreed at WG1 #6 with optimisation according to the simulation results presented in [2].

The "General" section on ordinary transmit power control (5.1.2.2.1) describes the changes in transmit power which are executed in response to the different possible values of "TPC_cmd", which is derived from the received TPC commands by means of Algorithm 1 or Algorithm 2. TPC_cmd may now have the values 1, 0 or –1, although

For clarity, two subsections have been created for the descriptions of Algorithm 1 and Algorithm 2. The description for Algorithm 1 is divided into 3, showing how the values of TPC_cmd are derived:

- when the UE is not in soft handover, and only one TPC command is received in each slot;
- when the UE is in soft handover and some received TPC commands are known to be the same (based on the previous section 5.1.2.2.2 in [1]);
- when the UE is in soft handover and some of the received TPC commands are not known to be the same (based on the previous section 5.1.2.2.3 in [1]).

The extent of the description for Algorithm 2 is limited to the non-soft-handover case.

The minor changes to section 5.1.2.3 on uplink power control in compressed mode are not presented here but are still shown in [1].

References

[1] TSGR1#6(99)b42 *"Text proposal on power control"*, Philips, August 1999

[2] TSGR1#7(99)b41 *"Algorithm 2 Power Control in Normal Mode"*, Philips, August 1999

5 Power control

5.1 Uplink power control

5.1.1 PRACH

< Editor’s note: This clause describes open loop power control scheme for PRACH. To be confirmed appropriate S documents for open loop power control, and moved this description to the appropriate S document.>

- The transmitter power of UE shall be calculated by following equation:
  $P_{RACH} = L_{Perch} + I_{BTS} +$ Constant value
  where,
  P_{RACH}: transmitter power level in dBm,
  L_{Pearch}: measured path loss in dB,
  I_{BTS}: interference signal power level at BTS in dBm, which is broadcasted on BCH,
  Constant value: This value shall be designated via Layer 3 message (operator matter).

5.1.2 DPCCH/DPDCH

5.1.2.1 General

The uplink 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. The relative transmit power offset between DPCCH and DPDCHs is determined by the network and signalled to the UE using higher layer signalling.

5.1.2.2 Ordinary transmit power control

5.1.2.2.1 General

The initial uplink transmit power to use is decided using an open-loop power estimate, similar to the random access procedure. *< Editor's note: This needs to be elaborated, how is the estimate derived? >*

The maximum transmission power at the maximum rate of DPDCH is designated for uplink and control must be performed within this range. *< Editor’s note: The necessity of this range needs to be confirmed.* > The maximum transmit power value of the closed-loop TPC is set by the network using higher layer signalling.

The uplink closed-loop power control adjusts the UE transmit power in order to keep the received uplink signal-to-interference ratio (SIR) at a given SIR target, SIR_{target}. An higher layer outer loop adjusts SIR_{target} independently for each cell in the active set.

The serving cells (cells in the active set) should estimate signal-to-interference ratio SIR_{est} of the received uplink DPCH . The serving cells then generates TPC commands and transmits the commands once per ms slot according to the following rule: if $SIR_{est} > SIR_{target}$ then the TPC command to transmit is “0”, while if $SIR_{est} < SIR_{target}$ then the TPC command to transmit is “1”.

~~If multiple TPC commands are received, then ~~U~~u~~pon reception of one or more~~these~~ TPC commands in a slot, the UE ~~combines the received commands into~~ derives a single TPC command, TPC_cmd, for each slot, combining multiple TPC commands if more than one is received in a slot. Two algorithms shall be supported by the UE for ~~The combination process~~deriving a TPC_cmd, as described in subclauses 5.1.2.2.2 and 5.1.2.2.3. Which of these two algorithms is used is a UE-specific parameter and is under the control of the UTRAN. ~~depends on whether the transmitted TPC commands are known to be the same or not. The combination process for each of these two cases is described in subclauses 5.1.2.2.2 and 5.1.2.2.3 respectively.~~

The step size Δ_{TPC} is a UE specific parameter, under the control of the UTRAN, that can have the values 1 dB or 2 dB.

Note : the maximum power control step to be support by the UE shall be 3 dB, 3 dB being allowed for the compressed mode. It is FFS whether the 3 dB should also be allowed in normal mode.

Two algorithms shall be supported by the UE and are described in the following sections :

5.1.2.2.1.1 Algorithm 1

After calculation ofderiving the combined TPC command TPC_cmd using one of the two supported algorithms, the UE shall adjust the transmit power of the uplink dedicated physical channels with a step of Δ_{TPC} dB according to the TPC command. If TPC_cmd equals 1 then the transmit power of the uplink DPCCH and uplink DPDCHs shall be increased by Δ_{TPC} dB. If TPC_cmd equals 0 -1 then the transmit power of the uplink DPCCH and uplink DPDCHs shall be decreased by Δ_{TPC} dB. If TPC_cmd equals 0 then the transmit power of the uplink DPCCH and uplink DPDCHs shall be unchanged.

The Any power increase or decrease shall take place immediately before the start of the pilot field on the DPCCH.

5.1.2.2.1.2 Algorithm 2

After calculation on a slot basis of the combined TPC command (TPC_cmd) for N consecutive slots, the UE will determine a global command. The set of N concatenated commands do not overlap (no running concatenation), and the sets are aligned to the frame boundary. This global command will result in an increase or decrease of the transmit power of the uplink dedicated physical channels with a step of Δ_{TPC} dB or no change of the transmit power.

The exact computation of the global command to calculate every N slots was agreed as a working assumption. Characteristics of this algorithms are as follows :

N=3 or N=5

Hard decision on the N commands is performed

A power increase or decrease is applied if the N commands are identical

Editor's note : The deadline for the number of concatenated commands and other details is WG1#7, in absence of input at WG1#7 the above described algorithm with N=3 will become the agreement. A more detailed text proposal needs to be done, and the behaviour in compressed mode as well as soft handover with TPC combining needs to be elaborated. >

NOTE : The algorithm 2 allows to emulate smaller step sizes than the minimum power control step as specified above.

The power increase or decrease shall take place immediately before the start of the pilot field on the DPCCH.

5.1.2.2.1.13 Out of synchronisation handling

5.1.2.2.2 Algorithm 1 for processing TPC commands

5.1.2.2.2.1 Derivation of TPC_cmd when only one TPC command is received in each slot

When a UE is not in soft handover, only one TPC command will be received in each slot. In this case, the value of TPC_cmd is derived as follows:

- If the received TPC command is equal to 0 then TPC_cmd for that slot is –1.
- If the received TPC command is equal to 1, then TPC_cmd for that slot is 1.

5.1.2.2.2.2 Combining of TPC commands known to be the same

When a UE is in soft handover, multiple TPC commands may be received in each slot from different cells in the active set. In some cases, the UE has the knowledge that some of the transmitted TPC commands in a slot are the same. This is the case e.g. with receiver diversity or so called softer handover when the UTRAN transmits the same command in all the serving cells the UE is in softer handover with. For these cases, the TPC commands known to be the same are combined into one TPC command, to be further combined with other TPC commands as described in subclause 5.1.2.2.2.3~~3~~.

5.1.2.2.2.3 Combining of TPC commands not known to be the same

In general in case of soft handover, the TPC commands transmitted in the same slot in the different cells may be different.

This subclause describes the general scheme for combination of the TPC commands not known to be ~~different~~ the same and then provides an example of such scheme. It is to be further decided what should be subject to detailed standardisation, depending on final requirements. The example might be considered as the scheme from which minimum requirement will be derived or may become the mandatory algorithm.

5.1.2.2.2.3.1 General scheme

First, the UE shall estimate the signal-to-interference ratio PC_SIR_i on each of the power control commands TPC_i, where i = 1, 2, …, N and N is the number of TPC commands not known to be ~~different~~the same, that may be the result~~s~~ of a first phase of combination according to subclause 5.1.2.2.~~3~~2.2.

Then the UE assigns to each of the TPC_i command a reliability figure W_i, where W_i is a function β of PC_SIR_i, $W_i = \beta(PC\_SIR_i)$. Finally, the UE derives a combined TPC command, TPC_cmd, as a function γ of all the N power control commands TPC_i and reliability estimates W_i:

$TPC\_cmd = \gamma\ (W_1, W_2, \ldots W_N, TPC_1, TPC_2, \ldots, TPC_N)$, where TPC_cmd can take the values ~~0~~ 1 or -1.

5.1.2.2.2.3.2 Example of the scheme

A particular example of the scheme is obtained when using the following definition of the functions β and γ:

For β: the reliability figure W_i is set to 0 if $PC\_SIR_i < PC\_thr$, otherwise W_i is set to 1. This means that the power control command is assumed unreliable if the signal-to-interference ratio of the TPC commands is lower than a minimum value PC_thr.

For γ: if there is at least one TPC_i command, for which $W_i = 1$ and $TPC_i = 0$, or if $W_i = 0$ and $TPC_i = 0$ for all N TPC_i commands, then TPC_cmd is set to ~~0~~-1, otherwise TPC_cmd is set to 1. Such a function γ means that the power is decreased if at least one cell for which the reliability criterion is satisfied asks for a power decrease.

5.1.2.2.3 Algorithm 2 for processing TPC commands

Note : Algorithm 2 makes it possible to emulate smaller step sizes than the minimum power control step specified in section 5.1.2.2.1, or to turn off uplink power control by transmitting an alternating series of TPC commands.

< The use or otherwise of Algorithm 2 in soft handover is FFS. >

5.1.2.2.3.1 Derivation of TPC_cmd when only one TPC command is received in each slot

When a UE is not in soft handover, only one TPC command will be received in each slot. In this case, the UE shall process received TPC commands on a 5-slot cycle, where the sets of 5 slots shall be aligned to the frame boundaries and there shall be no overlap between each set of 5 slots.

The value of TPC_cmd is derived as follows:

- For the first 4 slots of a set, TPC_cmd = 0.
- For the fifth slot of a set, the UE uses hard decisions on each of the 5 received TPC commands as follows:
  - If all 5 hard decisions within a set are 1 then TPC_cmd = 1 in the 5^{th} slot.
  - If all 5 hard decisions within a set are 0 then TPC_cmd = -1 in the 5^{th} slot.
  - Otherwise, TPC_cmd = 0 in the 5^{th} slot.