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TSGR1#7bis(99)f87

Agenda Item : AdHoc-9
Source : Nortel Networks
Title : Update on Power Over-Shoot Protection for Normal Mode
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1. Introduction

In TSGR1#7(99)c48, further clarifications on the power overshooting issue in the normal mode inner loop power control are presented. In this contribution, we present an update and text proposal on power over-shoot suppression.

2. Advantages of Power Over-Shoot Suppression

The excessive power over shoot associated with inner-loop power control was identified in TSGR1#7(99)666. The algorithm for suppressing the power over shoot was finalized in TSGR1#7(99)c48. It is basically a conditional power step size adaptation based on the analysis of the TPC bits stream at UE.

The algorithm described in TSGR1#7(99) c48 is as follows:

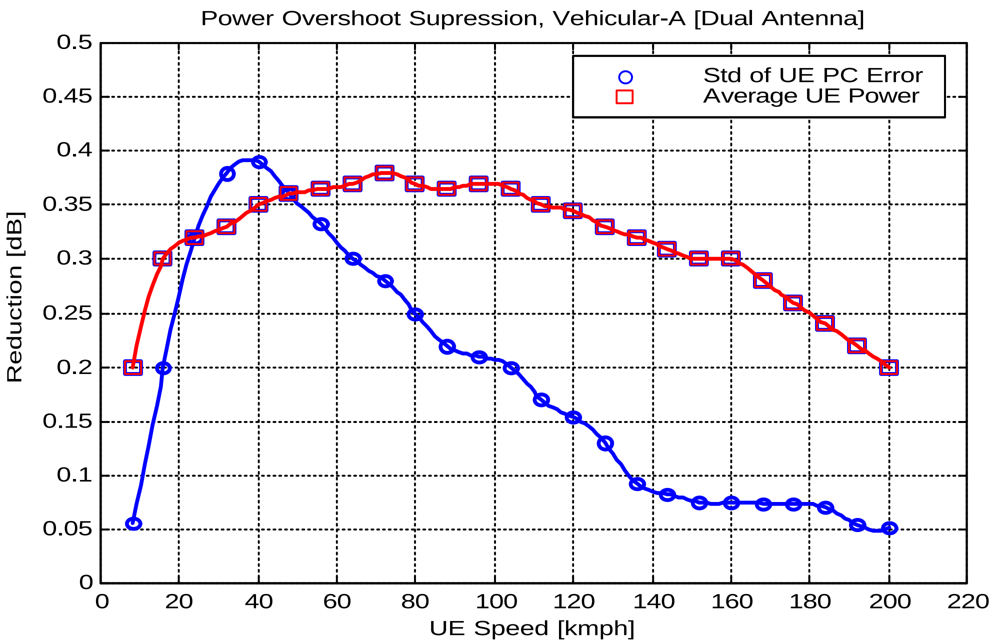
- If UE receives TPC=0, UE reduces transmit power by 1dB
- If UE receives TPC=1, UE increase transmit power by 1dB
- If UE detects 8 TPC=1 commands within the last received 10 TPCs, then UE should monitor the next TPC=0 command, and reduce transmit power by 2dB at the transition of TPC=1 to TPC=0.

The use of this algorithm is restricted to the normal mode, when the power control step is 1 dB and algorithm 1is used.

The algorithm is simple and has the following advantages:

- The standard deviation of power control error is reduced
- The average UE transmission power is reduced.
- The inter/intra cell interference is reduced.
- The capacity is increased.

The use the power over shooting suppression will not degrade the link performance and this is confirmed by an independent simulation from SK Telecom in TSGR1#7(99)c62, although simulation results presented in TSGR1#7(99)c48. Indicate a link performance improvement. In this contribution, we present a further result showing by suppression the power over shooting, the UE average transmission power can be reduced. This is because after the suppression of over-shoot portion power, the UE power control error distribution is changed such that the power control can still meet the target out-loop SIR and the required Eb/No. The standard deviation of power control error and UE average transmission power reduction are shown in Figure 1.



The power control error standard deviation without over-shoot suppression is about 2.5dB. Based on the capacity loss due to imperfect power control shown in TSGR1#5(99)667, after power control standard deviation reduction achieved by suppression of power over shoot, the capacity increase is about more than 10%. Based on the available results, we propose to modify of the power control in normal mode to incorporate the overshooting protection. A text proposal is attached.

3. References

[1] : R1-99c48, Clarification on Power Over-Shoot Protection for Normal Mode, Nortel Network

[2] : R1-99667,

4. Text Proposal

4. 5.1.2.2 Ordinary transmit power control

5. 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 inner-loop TPC is set by the network using higher layer signalling.

The uplink inner-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".

Upon reception of one or more TPC commands in a slot, the UE 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 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.

The step size $\Delta_{TPC\text{-}UTRAN}$ is a UE specific parameter, under the control of the UTRAN, that can have the values 1 dB or 2 dB. The UE shall increase or decrease its transmit power by steps of Δ_{TPC}, where Δ_{TPC} is derived from $\Delta_{TPC\text{-}UTRAN}$ as indicated in each of the following sections. $\Delta_{TPC} = \Delta_{TPC\text{-}UTRAN}$ unless otherwise stated.

After deriving of 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 -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.

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

6. 5.1.2.2.1.1 Out of synchronisation handling

7. 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.

The setting of Δ_{TPC} shall be as follows :

If $\Delta_{TPC\text{-}UTRAN}$ =1dB,

$\Delta_{TPC} = \Delta_{TPC\text{-}UTRAN}$ unless the following condition is satisfied : the power control command for the current slot TPC_cmd=0, the previous TPC_cmd=1 and within the 10 last TPC_cmd including the current one, 8 commands verify TPC_cmd=1. In such a case Δ_{TPC}=2dB

If $\Delta_{TPC\text{-}UTRAN}$ =2dB,

$\Delta_{TPC} = \Delta_{TPC\text{-}UTRAN}$. It is FFS whether the Δ_{TPC} can be adjusted as a result of consecutive commands triggering an increase of the power.

~~3.~~8. 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. The setting of Δ_{TPC} is the same as in section 5.1.2.2.2.1

9. 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 different cells may be different. This subclause describes the general scheme for combination of the TPC commands known to be different 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.

10. 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 the same, that may be the result of a first phase of combination according to subclause 5.1.2.2.2.2.
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:
$TPC\_cmd = \gamma (W_1, W_2, \dots W_N, TPC_1, TPC_2, \dots, TPC_N)$, where TPC_cmd can take the values 1 or -1.

The setting of Δ_{TPC} is such that $\Delta_{TPC} = \Delta_{TPC-UTRAN}$

11. 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 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.