TSG-RAN Working Group Meeting #7 *TSGR1#7(99)c48*
Hannover, Germany, Aug.30-Sept.3, 1999

Agenda Item : **AdHoc-9**
Source: **Nortel Networks**
Title: **Clarification on Power Over-Shoot Protection for Normal Mode**
Document for: **Decision**

1. Introduction

In TSGR1#5(99)666, a condition was proposed to impose on the normal mode power control, the rationale behind is to suppress the power overshoot caused by the closed loop fast power control. While effectively suppressing the excessive power over shoots at the UE and Node-B, the overall intra-inter cell interference can be reduced.In TSGR1#5(99)666 presented during the last ad-hoc 09 meeting, initial results were presented. As a result of the discussion in ad-hoc 09 further results are shown in this contribution., Such results indicate that in addition to the power control error standard deviation reduction, resulting in a reduced interference, the algorithm allows link performance improvement depending on the UE speed. 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.

2. Power Over-Shoot Suppression

In TSGR1#5(99)666, a parameterized algorithm is presented. Although the performance can be further optimized with the a priori knowledge of UE speed. In this contribution, we propose to finalize algorithm parameters which can achieve good performance for all range of UE speed.

The algorithm is specified here for the case the power control step is 1dB and the power control algorithm is based on algo 1, that is to say that emulated steps are not used.

The algorithm can be simplified 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.

In the following, we present the simulation results and performance comparison.

2.1 Simulation Conditions

In Table-1, the simulation feature is listed, 150,000 slots have been simulated.

Table 1 Simulation Conditions

Carrier Frequency	2-GHz
Frame Structure	10ms, 15-slot/frame
Diversity Antenna	2 (non-correlated Rayleigh fading)
RAKE Combining	2-fingers/antenna
Channel Estimation	3-slot FIR
DPDCH	SF=256
Normal Mode Power Control	SIR based closed loop
TPC Delay	1-slot

Power Control Step	1-dB
TPC Error	additive 5% error
Channel Model	Vehicular-A (ITU)

2.2 Simulation Results

Figure 1 shows the closed-loop power control error standard deviation reduction. It can be seen that the for the all UE speed range, the algorithm can effectively reduced the power control error by suppression over-shoot power. The parameter finalized in this section is chosen to provide most standard deviation reduction in the median range of the mobility speed.

Figure 1. Power Control Error Reduction (Standard Deviation)

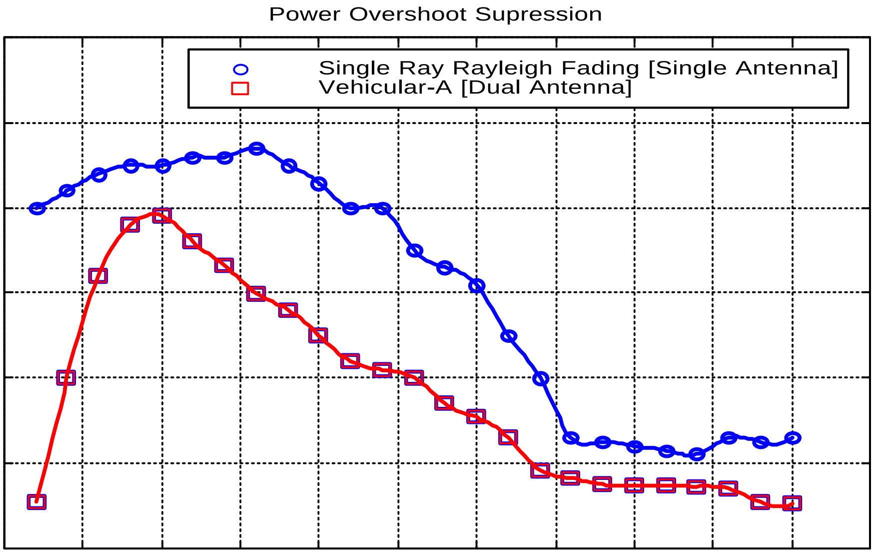
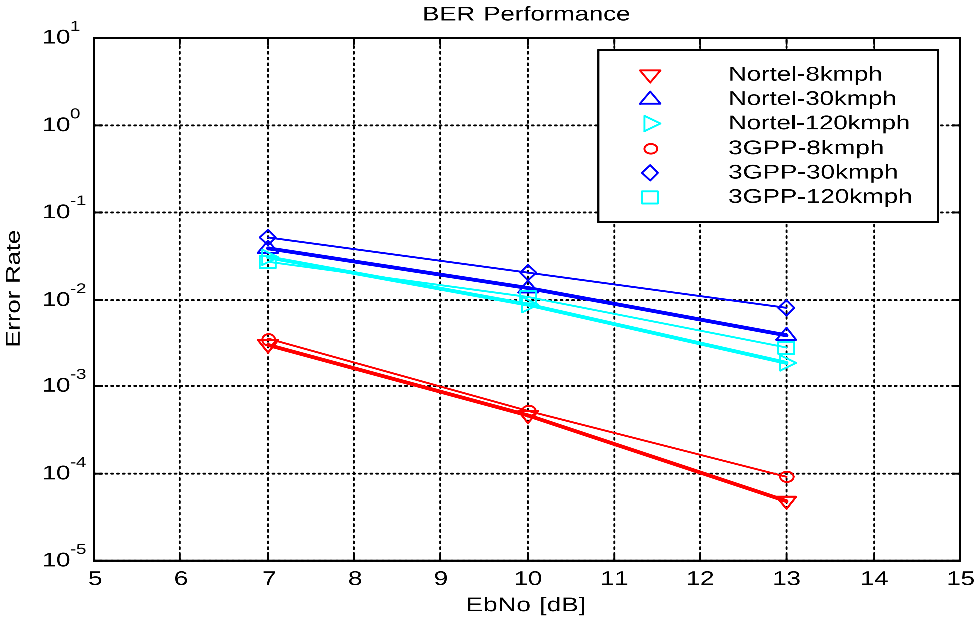


Figure 2. Comparison of Power Overshoot Suppression and 3GPP Algorithms



5. Conclusions

We propose to impose a condition on the normal mode closed loop power control to suppress the power over shoot, when the power control algorithm used is algo 1. The proposed algorithm allows UE conditionally use 2dB step to suppress the power over-shoot UE generated after deep fade period, assuming that the power control step is 1 dB. The proposed algorithm can reduce the UE power control error and improve the link performance. Further work is needed when the power control step is 2dB. A text proposal is attached.

3. Text Proposal

-- Text Proposal --

3. 5.1.2.2 Ordinary transmit power control

4. 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 upon reception of these TPC commands, the UE combines the received commands into a single TPC command, TPC_cmd. The combination process 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 $\Delta_{TPC\text{-}UTRAN}$ is a UE ~~specific~~ parameter controlled by 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. 5.1.2.2.1.1 Algorithm 1

After calculation of the combined TPC command TPC_cmd, 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 then the transmit power of the uplink DPCCH and uplink DPDCHs shall be decreased by Δ_{TPC} dB.
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.

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

6. 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 $\Delta_{TPC\text{-}UTRAN}$ 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 :

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7. 5.1.2.3 Transmit power control in compressed mode

< Note: The following is a working assumption of WG1. >
The aim of uplink power control in downlink or/and uplink compressed mode is to recover as fast as possible a signal-to-interference ratio (SIR) close to the target SIR after each transmission gap.
In downlink compressed mode, no power control is applied during transmission gaps, since no downlink TPC command is sent. Thus, the transmit powers of the uplink DPDCH(s) and DPCCH are not changed during the transmission gaps.
In simultaneous downlink and uplink compressed mode, the transmission of uplink DPDCH(s) and DPCCH is stopped during transmission gaps. <*Note: the initial transmit power of each uplink DPDCH or DPCCH after the transmission gap is FFS.* >.
After each transmission gap, 2 modes are possible for the power control algorithm. The power control mode (PCM) is fixed and signalled with the other parameters of the downlink compressed mode (see TS 25.231). The different modes are summarised in the table 1:

Table 1. Power control modes during compressed mode.

Mode	**Description**
0	Ordinary power control is applied with step size $\Delta_{TPC\text{-}UTRAN}$
1	Ordinary power control is applied with step size $\Delta_{RP\text{-}TPC}$ during one or more slots after each transmission gap.

<Note: The exact power control algorithm in compressed mode when concatenation of TPC commands are used in normal mode is still FFS. The current description only applies when no concatenation is done in normal mode. >
For mode 0, the step size is not changed and the ordinary power control is still applied during compressed mode (see subclause 5.1.2.2).
For mode 1, during one or more slots after each transmission gap, called the recovery period, the ordinary power control algorithm is applied but with a step size $\Delta_{RP\text{-}TPC}$ instead of Δ_{TPC}, where $\Delta_{RP\text{-}TPC}$ is called recovery power control step size and is expressed in dB. The step size $\Delta_{RP\text{-}TPC}$ is equal to the minimum value of 3 dB and $2\Delta_{TPC\text{-}UTRAN}$.
After the recovery period the ordinary power control algorithm with step $\Delta_{TPC\text{-}UTRAN}$ is performed.
The recovery period length (RL) determination is still FSS and is to be chosen between the two following possibilities:

- The recovery period length is fixed and derived as a function of the Transmission mode parameters mostly the transmission gap period and possibly the spreading factor.
- The recovery period length is adapted and ends when the current and previous received power control commands are opposite or after TGL slots after the transmission gap.