3GPP TSG RAN TSGR1#5(99)542

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Additional results for fixed-step closed loop power control algorithm in compressed mode

1. Introduction

Alcatel proposes an uplink (resp. downlink) closed loop power control algorithm in downlink (resp. uplink) compressed mode in order to recover faster a SIR close to SIR_{target} when transmission is resumed (see [1]). It consists basically in increasing power control step during a certain amount of time (*recovery period*) after transmission restarts. This article presents numerous simulations results confirming the excellent performances of the proposed algorithm, whatever the conditions.

2. Simulation results

The detailed parameters of the simulations and the description of the proposed algorithm are given in appendix at the end of this document. The curves present the Eb/No required for a quality BER of 10^{-3} for speech service. Simulation results are given with both ideal and basic SIR estimation (using pilot bits of the current slot). Results with basic SIR estimation could be improved using data symbols or SIR averaging over several slots.

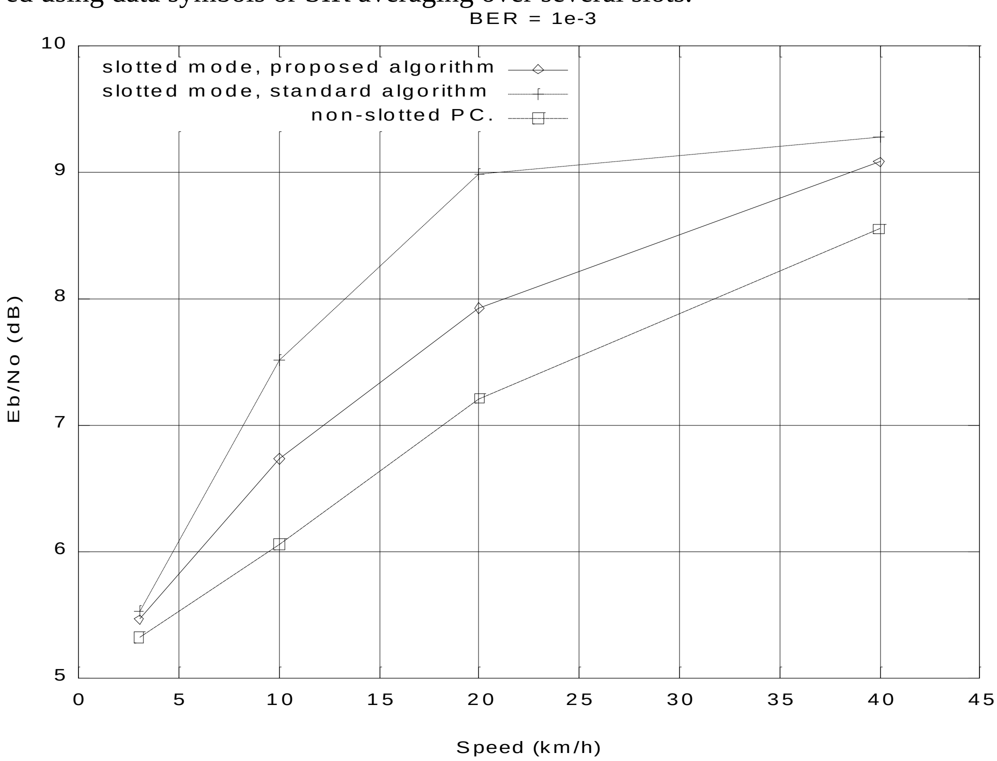

Figure 1. Pedestrian A. Downlink. Ideal SIR estimation.

In downlink, with ideal SIR estimation (Figure 1), we observe an improvement of the proposed algorithm compared to the standard one for all simulated speeds (3 to 100 km/h). At 20 km/h, this improvement is larger than **1 dB**.

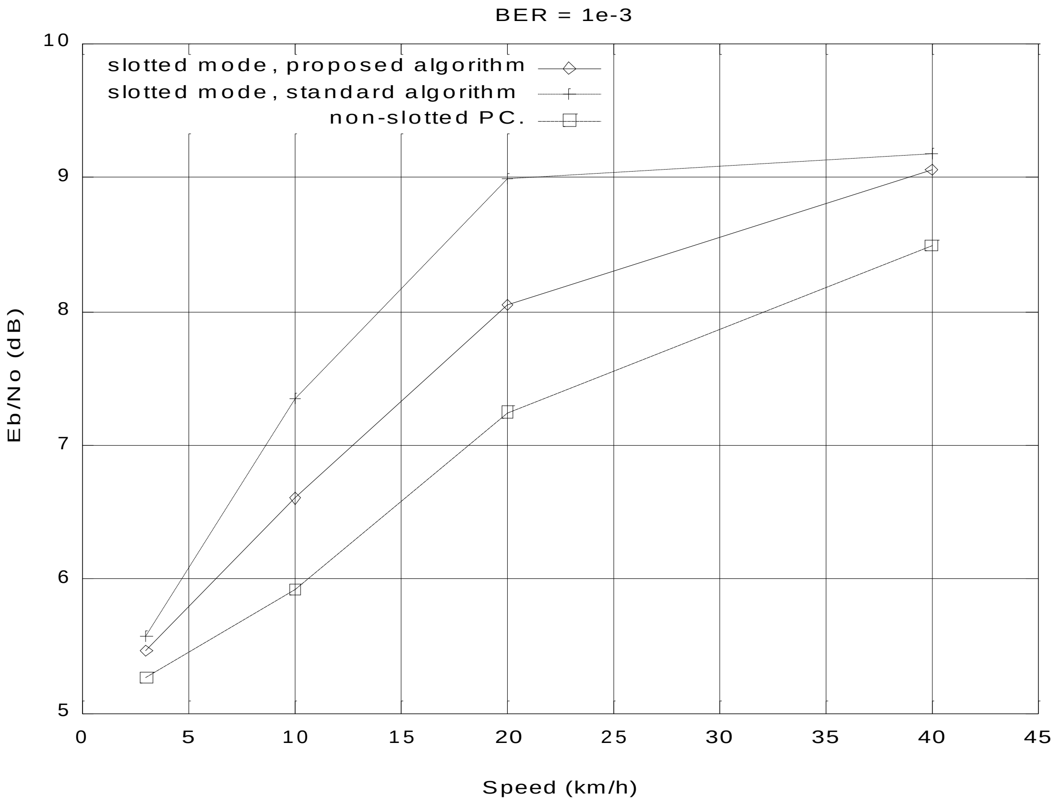

Figure 2. Pedestrian A. Uplink. Ideal SIR estimation. 1 antenna.

In uplink, with ideal SIR estimation (Figure 2), the improvement brought by our algorithm is of the same order as in downlink (up to 1 dB).

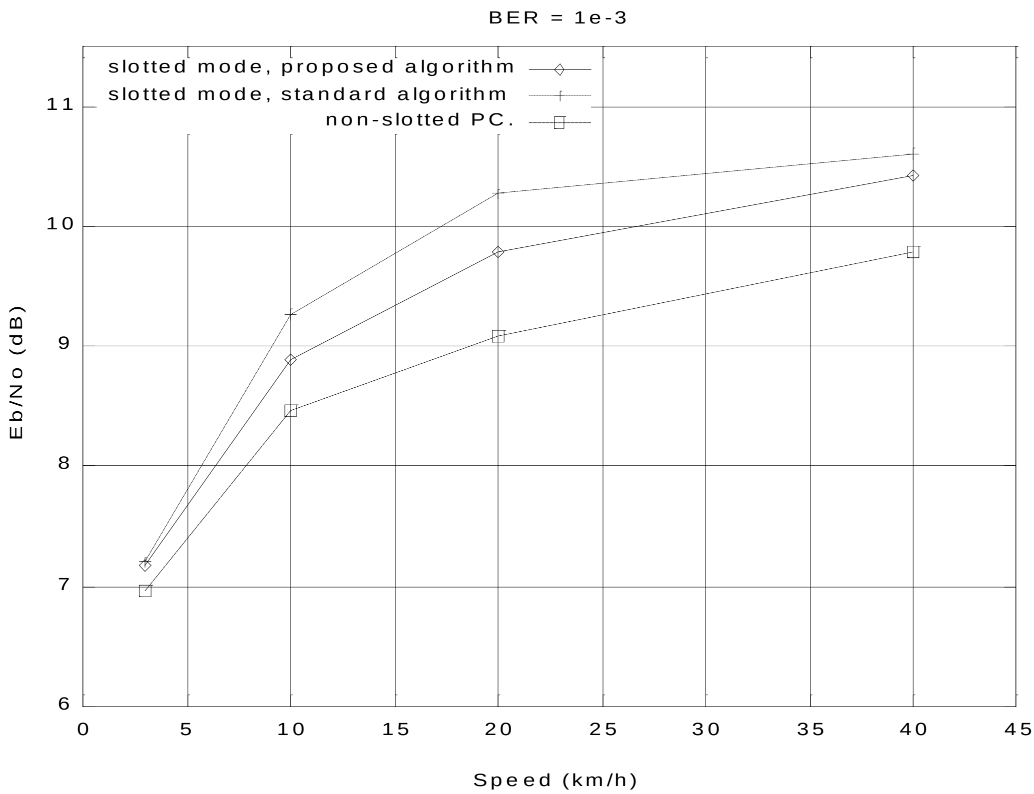

Figure 3. Pedestrian A. Downlink. SIR estimated with pilot bits.

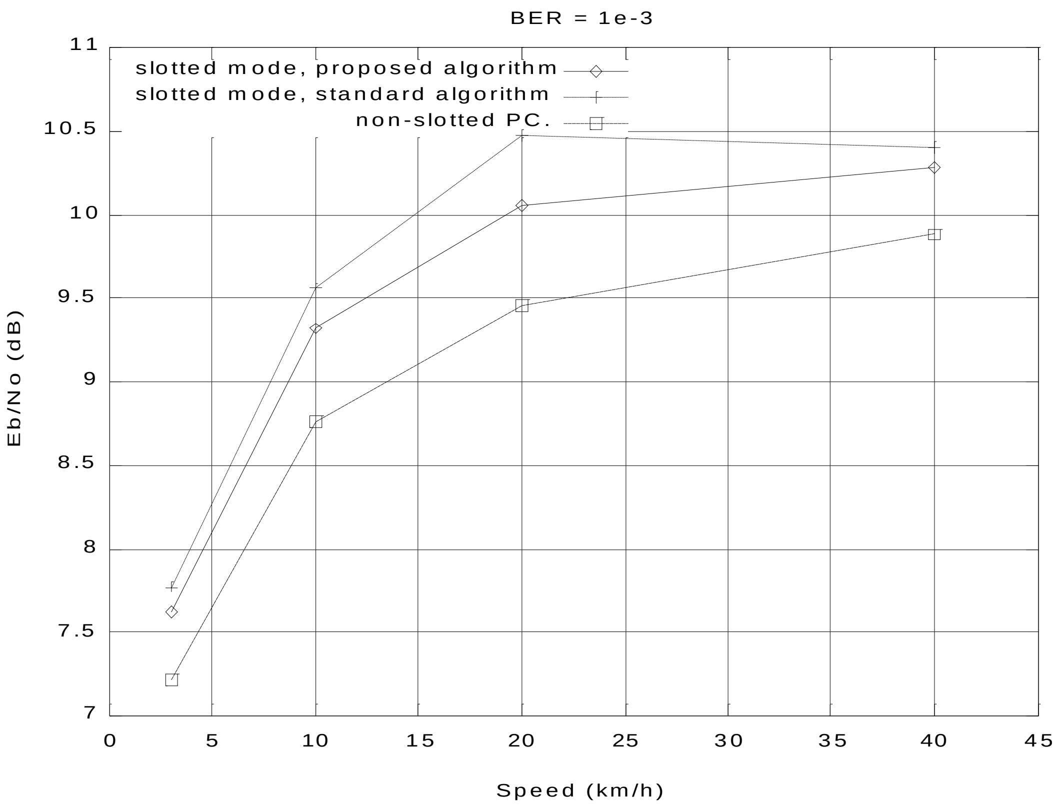

Figure 4. Pedestrian A. Uplink. SIR estimated with pilot bits.

In downlink, when SIR is estimated with the help of pilot bits (Figure 3), the proposed algorithm is still better than the standard one. At 20 km/h, we observe a performance improvement of **0.5 dB** in downlink and **0.4 dB** in uplink (see Figure 4). With better SIR estimation (using averaging over several slots, data symbols, …), the gain would be larger (up to 1.1 dB obtained with ideal SIR estimation).

Table 1 summarizes the improvements of proposed algorithm compared to the standard one. Comparative results at 100 km/h have been added to show that our fixed step algorithm does not degrade performances at high speed.

Speed (km/h)	**DL, IDEAL**	**UL, IDEAL**	**DL, PILOT**	**UL, PILOT**
3	0.1	0.1	0.0	0.2
10	0.8	0.8	0.4	0.2
20	**1.1**	1.0	0.5	0.4
40	0.2	0.1	0.2	0.1
100	0.1	0.0	0.0	0.1

Table 1. Difference between proposed and standard algorithm (in dB)

3. Conclusion

Alcatel proposes a very simple algorithm for uplink (resp. downlink) closed loop power control in downlink (resp. uplink) compressed mode. The results presented in this paper demonstrate that it leads to important improvements (up to **1.1** dB with ideal SIR estimation**,** up to **0.5 dB** with basic SIR estimation performed on pilot bits).

Appendix

Simulation parameters

We have considered the fact that the error on the TPC bits is larger when we are in the recovery period. Indeed, error on TPC bits is set to 4% out of the recovery period, and it is set to 7% in the recovery period (this value is a simulation result). This assumption is reminded in the following tables.

Parameters	Values, assumptions, …
Service	**Speech**
Carrier frequency	2 GHz
Channel	Indoor to Outdoor and Pedestrian A channel where the delays of the different paths are multiple of the chip period.
Link direction	Uplink
Power control	- Fixed step of 1 dB in normal mode. - 1 slot delay (=0.625 ms) - Infinite dynamic range - Error rate on TPC commands: 7% in recovery period, 4% elsewhere (see [3]). The SIR estimation is ideal (the channel energy is used), or performed with pilot bits.
Eb/N0 scaling	Eb is computed as the received power for each information bit including all overhead (coding, tail, pilot, TPC, TFCI, rate matching, CRC)
Rake receiver	2 fingers/antenna. An ideal path searcher with fixed delays is used. The oversampling rate is the chip rate.
Channel estimation method	Channel estimation is based on the present pilot group and pilot groups before and after the present slot. The different pilot groups are multiplied by a weighting factor. The different weights only depend on speed and are : - 3 km/h : (1, 1, 1, 1, **1**, 1, 1) - 10 km/h : (1, 1, 1,1, **1**, 1, 1) - 20 km/h : (0.9, 1, 1, 1, **1**, 1, 1) - 40 km/h : (0.7, 0.8, 0.9, 1, **1**, 1, 0.9) - 100 km/h : (0.2, 0.6, 0.9, **1**, 0.9, 0.6) where the current slot has the weight in bold font.
Slotted mode	Transmission gap period (TGP) = 64 slots. Transmission gap length (TGL) = 8 slots. For the proposed algorithm: recovery length of 8 slots (RL); power control step of 2 dB and error rate on TPC commands of 7% during the recovery periods.
Information bit rate	8 kbps
Physical channel rate	32 kbps (sf=128)
Number of info bits per frame	80
CRC	16 bits
Coding	Convolutional coding Constraint length 9, rate 1/3, 8 tail bits
Rate matching	Repetition: 8 bits
Interleaving	10 ms

Pilot/TPC/TFCI bits per slot	6/2/2
Number of reception antennas	1
DPCCH/DPDCH power	-3 dB
Inter-users interference	Modeled as AWGN noise. It is assumed constant and known in the simulations.

Table 2. Parameters setting for simulations in uplink.

Parameters	Values, assumptions, …
Service	**Speech**
Carrier frequency	2 GHz
Channel	Indoor to Outdoor and Pedestrian A channel where the delays of the different paths are multiple of the chip period.
Link direction	Downlink
Power control	- Fixed step of 1 dB in normal mode. - 1 slot delay (=0.625 ms) - Infinite dynamic range - Error on TPC commands: 7% in recovery periods, 4% elsewhere (see [3]). The SIR estimation is ideal (the channel energy is used), or performed with pilot bits.
Eb/N0 scaling	Eb is computed as the received power for each information bit including all overhead (coding, tail, pilot, TPC, TFCI, rate matching, CRC)
Rake receiver	2 fingers/antenna. An ideal path searcher with fixed delays is used. The oversampling rate is the chip rate.
Channel estimation method	Channel estimation is based on the present pilot group and pilot groups before and after the present slot. The different pilot groups are multiplied by a weighting factor. The different weights only depend on speed and are : - 3 km/h : (1, 1, 1, 1, **1**, 1, 1) - 10 km/h : (1, 1, 1,1, **1**, 1, 1) - 20 km/h : (0.9, 1, 1, 1, **1**, 1, 1) - 40 km/h : (0.7, 0.8, 0.9, 1, **1**, 1, 0.9) - 100 km/h : (0.2, 0.6, 0.9, **1**, 0.9, 0.6) where the current slot has the weight in bold font.
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Information bit rate	8 kbps
Physical channel rate	32 kbps (sf=128)
Number of info bits per frame	80
CRC	16 bits
Coding	Convolutional coding Constraint length 9, rate 1/3, 8 tail bits
Rate matching	Repetition: 8 bits
Interleaving	10 ms

Pilot/TPC/TFCI bits per slot	8/2/0
Number of reception antennas	1
DPCCH/DPDCH power	0 dB
Inter-users interference	Modeled as AWGN noise. It is assumed constant and known in the simulations.

Table 3. Parameters setting for simulation in downlink.

Proposed algorithm

The proposed algorithm is as follows:

Every time slot (TS),

1) if we are in the transmission gap, do not perform any power control action
2) if we are in the recovery period, perform CLPC algorithm with step Δ' > Δ
3) if we are not in one of those 2 cases, perform CLPC algorithm with step Δ

We remind that the CLPC algorithm with step Δ can be written:

Every TS,

1) the BTS estimates the average received SIR during the TS
2) the BTS compares this SIR to SIR_{target}

- if $SIR>SIR_{target}$, the BTS sends a “down” TPC command to the UE, and UE decreases its power by Δ dB.
- if $SIR<SIR_{target}$, the BTS sends a “up” TPC command to the UE, and UE increases its power by Δ dB.

References

[1] TSGR1#4(99)342. Improved closed loop power control in compressed mode. Alcatel. (04/1999).

[2] TSGR1#5(99)544. Parameters setting for fixed-step closed loop power control in compressed mode. Alcatel. (05/1999).

[3] TSGR1#5(99)543. Evaluation of average error rate on power control commands in compressed mode. Alcatel. (05/1999).