3GPP TSG RAN TSGR1#5(99)543

Working group 1, meeting #5

Cheju (Korea), June, 1-4th 1999

Source: Alcatel

Evaluation of average error rate on power control commands in compressed mode

1. Introduction

In [1], Alcatel proposed an algorithm that improves uplink (resp. downlink) closed loop power control performances in downlink (resp. uplink) slotted mode. This algorithm basically consists in applying a larger power control step during a certain amount of time when transmission restarts, in order to faster recover a signal-to-interference ratio (SIR) close to the target SIR. The proposed algorithm was shown to improve performances in a wide range of conditions and particularly with an average error probability on power control commands up to 15%.

During last meeting, it was questioned whether an average error probability of 15% was large enough or not, since the downlink signal is no longer controlled (nor transmitted!) during transmission gaps. In this document, we present some link level simulation results to demonstrate that an average error probability of 15% is a worse case and that the error rate on power control commands is usually even much lower.

After describing the model and parameters used in the simulations in section 2, the simulations results are presented in section 3. Section 4 is the conclusion.

2. Simulations model and parameters

The proposed algorithm simply consists in applying a larger step during a recovery period of a few slots after each transmission gap during compressed mode, in order to faster recover a SIR close to the target SIR. For a detailed description of this algorithm, please refer to [1].

To evaluate this average error rate on power control commands during the recovery periods, some link level simulations have been performed. It was evaluated for the target E_b/N_0 in non-compressed mode, i.e. for the E_b/N_0 required to reach a bit error rate (BER) of 10^{-3} for speech service. This error rate has been evaluated with the standard power control algorithm.

The parameters used for all the link level simulations are described in the following table.

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
Downlink power control	- Fixe step of 1 dB - 1 slot delay (=0.625 ms) - Infinite dynamic range - 4% random error on *uplink* TPC commands. The SIR estimation is done in pilot bits of the current slot.
Uplink TPC bits	2 TPC bits per slot are assumed
Eb/N0 scaling	E_b 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) - 25 km/h : (0.9, 0.9, 1, 1, **1**, 1, 1) where the current slot has the weight in bold font.
Downlink compressed mode	Gap period: 160 slots , gap length: 8 slots The proposed algorithm is not applied. The power control step remains constant equal to 1dB.
Inter-users interference	Modeled as AWGN noise. It is assumed constant and known in the simulations.
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 (and DTX)
Interleaving	10 ms
Pilot/TPC/TFCI bits per slot	8/2/0
Number of reception antennas	1 (no antenna diversity)

Table 1: *Simulation parameters and assumptions*

3. Simulation results

The error rate on power control commands has been evaluated for two speeds and for different power offsets between the downlink TPC bits and the data bits.

The error rate is either averaged on the whole recovery periods (8 slots each), see Table 2, or only on the first slot of the recovery periods, see Table 3. The error rate is larger when averaged only over the first slot of the recovery periods since the first slot of the recovery periods just follows the transmission gaps where no power control was performed. The error rate is better on the following slots of the recovery periods, since power control has been started again.

Note that the error rate on power control commands in normal mode (non-compressed mode) would be around 4%.

Speed	**Target E_b/N_0 (dB)**	**TPC bits have the same energy as data and pilot bits**	**TPC bits energy is 3 dB larger than data and pilot bits energy**
3 km/h	6.9	5.1 %	1.1 %
25 km/h	9.1	5.4 %	2.4 %

Table 2: *Power control commands error rate averaged over the whole recovery period, i.e. 8 slots (Speech service, pedestrian A)*

Speed	**Target E_b/N_0 (dB)**	**Δ=0**	Δ=5	Δ=6.8
3 km/h	6.9	5.3 %	0.3 %	< 0.1 %
25 km/h	9.1	7.1 %	2.4 %	1.6 %

Table 3: *Power control commands error rate averaged over the first slot of recovery period (Speech service, pedestrian A). D is the power offset between TPC symbols power and data symbols power in dB.*

At 3 km/h, the error rate on power control commands is similar when averaged over the first slot or all slots of the recovery periods, because the channel attenuation varies slowly in time and thus the SIR remains pretty close to the target SIR even in compressed mode. The difference is larger at 25 km/h.

4. Conclusion

The average error rate on power control commands is around 5.5% during the recovery periods in compressed mode at 3 and 25 km/h, instead of being 4% in normal mode. This error rate is a little larger at the beginning of the recovery period at 25 km/h (7% in the first slot). Thus, the error rate on power control commands is only slightly increased during the recovery periods and remains much below 15%.

Therefore, the simulations presented in [1] with an average error rate on power control commands of 15% are a very worse case. They enable to conclude that the proposed algorithm is very robust to the power control commands error rate, since it was shown that it enables to improve performances in compressed mode even in this case.

5. References

[1] UMTS RAN WG1 TSGR#4(99)342, "Improved closed loop power control algorithm in slotted mode" (Alcatel), *April, 99.*