TSG-RAN Working Group 1 (Radio layer 1) ***TSGR1#7(99)c24***
Hannover (Germany), August 30th - September 3rd 1999

Agenda Item: Ad-hoc 9

Source: Alcatel

Title: Comparison between algorithms with fixed and adaptive recovery period for fast power control in compressed mode

Document for: Decision

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1 Introduction

At the last WG1 meeting, a working assumption was agreed on fast power control in compressed mode. When the ordinary power control is not used in compressed mode, a specific algorithm can be used in order to hasten the recovery of a SIR close to the target SIR. This recovery algorithm only increases the power control step during a few slots after each transmission gap, called recovery period. At this point, we still have to decide whether :

1. The recovery period is fixed, possibly equal to the transmission gap length,
2. The recovery period is adapted and ends when the current and previous power control commands are opposite or after TGL slots after the transmission gap.

Adaptive algorithms like the algorithm 2 look usually attractive in theory. However, in practice, these algorithms are very sensitive to errors (SIR estimation errors, TPC commands errors, …) and show degraded performances compared to simple algorithms in realistic conditions. In compressed mode, the situation is even worse. Indeed, after each transmission gap where such algorithm is expected to be applied, the error rate on power control commands is larger than usual since the fast power control was interrupted during the transmission gap. For speech service at 20 km/h, the average error rate is around 7%, which means that the probability to end the recovery period after only one slot because of an error is roughly 15% (probability to have one error on two consecutive power control commands). This error rate would be significantly increased by taking into account SIR estimation errors. Thus, in many situations, the recovery period will end before recovering a SIR close to the target SIR, resulting in performance loss.

Thus, we recommend to have a fixed recovery period with a length equal to the transmission gap length since it would enable to have a robust and simple algorithm that was previously shown to allow some performance improvement compared to normal mode (see [1], [2] and [3]).

In the following section, we show that the performance is better with a fixed recovery period (algorithm 1) than with an adaptive recovery period (algorithm 2).

2 Simulation results

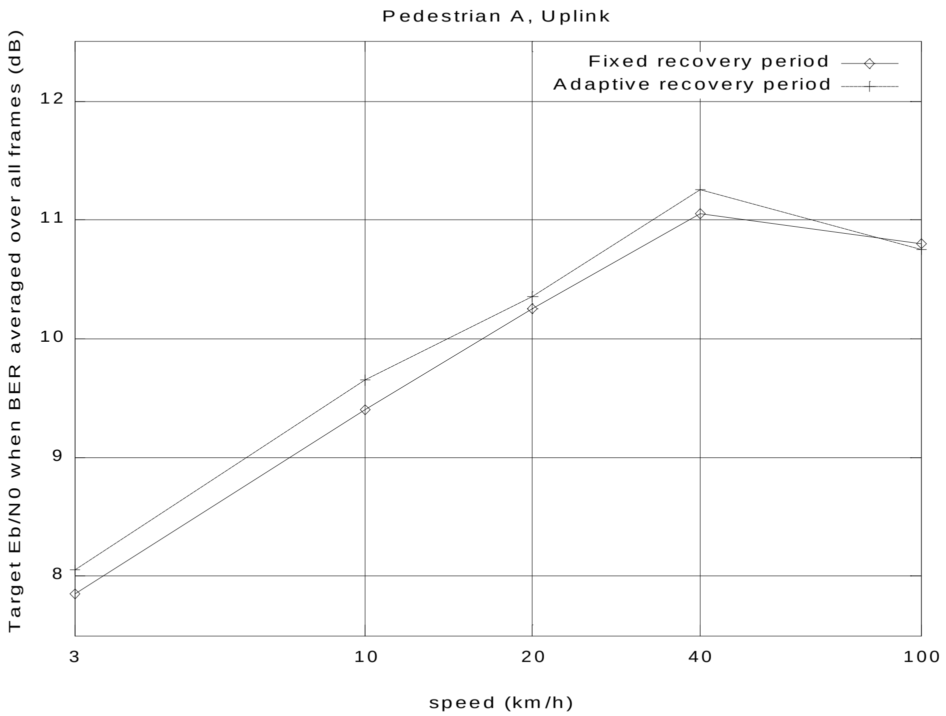
The link-level performance of the different schemes has been compared for speech service, pedestrian A environment, SIR estimation performed on pilot bits and speed ranging from 3 to 100 km/h. The transmission gap period and length were chosen to be respectively 4 frames and 8 slots. Detailed parameters are given in appendix.

In these link-level simulations, both links are simulated at the same time in order to have very accurate modeling of power control commands. Each link has been simulated at the chip level, thus taking into account spreading, scrambling and inter-chip interference created by the channel.

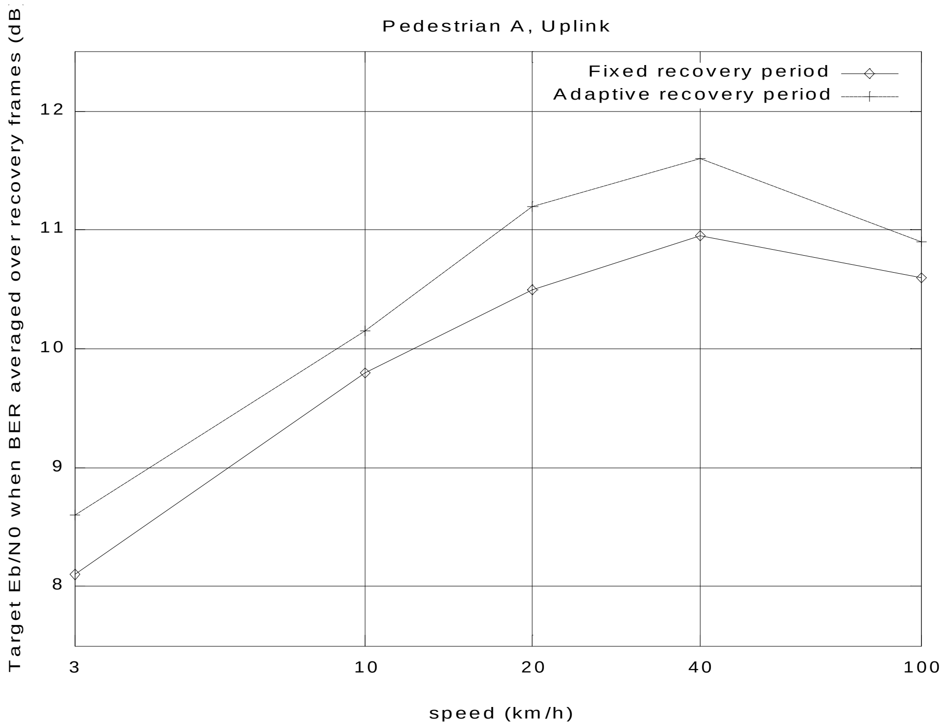
Simulation results are shown for the uplink, where the power control algorithm applied on the uplink power control is one of the proposed algorithms and the downlink power control algorithm is always the standard power control algorithm (the power control step is always 1 dB). The average E_b/N_0 of the downlink is the target E_b/N_0 and is the same for all schemes (but depends on the speed).

For each speed, two outputs are shown:
- The average received E_b/N_0 for a BER of 10^{-3} when the BER is averaged over all frames,
- The average received E_b/N_0 for a BER of 10^{-3} when the BER is averaged only over recovery frames (a recovery frame is the first frame after a compressed frame).

2.1 Average received E_b/N_0 when BER is averaged over all frames



2.2 Average received E_b/N_0 when BER is averaged over recovery frames



3 Text proposal

We propose to change the section 5.1.2.3. of TS 25.214 version 1.1.1. with the following text.

-- Beginning of text proposal ---

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 Δ_{TPC}
1	Ordinary power control is applied with step size $\Delta_{RP\text{-}TPC}$ during ~~one or more~~TGL 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~~TGL slots, 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 $2\Delta_{TPC}$.

After the recovery period the ordinary power control algorithm with step Δ_{TPC} is performed. The recovery period length (RL) ~~determination is still FSS and is to be chosen between the two following possibilities:~~is fixed and equal to TGL slots.

~~- 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.~~

-- End of text proposal --

4 References

[1] UMTS RAN WG1 TSGR1#4(99)342, "Improved closed loop power control algorithm in slotted mode" (Alcatel), *April, 99.*

[2] UMTS RAN WG1 TSGR1#5(99)542, "Additional results for fixed-step closed loop power control algorithm in compressed mode" (Alcatel), *June, 99.*

[3] UMTS RAN WG1 TSGR1#5(99)544, " Parameters setting for fixed-step closed loop power control algorithm in compressed mode" (Alcatel), *June, 99.*

[4] UMTS RAN WG1 TSGR1#5(99)638: "Comparison between fixed-step and adaptive-step closed loop power control algorithms in compressed mode" (Alcatel), *June, 99.*

[5] UMTS RAN WG1 TSGR1#6(99)881: "Comparison between fixed-step and adaptive-step closed loop power control algorithms in compressed mode" (Alcatel), *July, 99.*

5 Appendix: detailed simulation parameters

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.
Type of simulations	Both links are simulated at the same time at chip level.
Link direction for which the performances are estimated	Uplink
Harmonization impacts	Harmonization impacts are not taken into account in the simulations. Thus, the chip period is 0.244 ms and there are 16 slots per frame.
Uplink power control	- Infinite dynamic range, - One-slot delay - The power-control algorithm is one of the proposed algorithm in recovery zones or the standard power control algorithm with step equal to 1 dB otherwise.
Downlink power control	- Infinite dynamic range, - One-slot delay - The power-control algorithm is always the standard power control algorithm with step size equal to 1 dB.
E_b/N_0 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. 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. The Transmission gap is at the end of the compressed frame.
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 for uplink 8/2/0 for downlink
Number of reception antennas	1 (i.e. no antenna diversity)
DPCCH/DPDCH power	-3 dB for uplink 0 dB for downlink
Inter-users interference	Modeled as AWGN noise. It is assumed constant and known in the simulations.

Table 2: Simulation parameters