3GPP TSG RAN WG1 ***TSGR1#7(99)b41***
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Agenda item: **Ad hoc 9**

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Title: **Algorithm 2 Power Control in Normal Mode**

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1 Summary

In [1] we described a mechanism to enable the benefits of using power control step sizes smaller than 1dB to be realised, without requiring the UEs actually to implement such small step sizes.

In [2] we presented fuller simulation results for a number of different methods of emulating small power control steps, and showed that a simple method operated at the UE can give the best performance. The number, N, of TPC commands which were concatenated in the emulation process in [2] was 2 or 4.

The use of emulation of small steps is described as "Algorithm 2" in [3]. In view of the harmonisation proposals [4], we now present further simulation results for the "Algorithm 2" power control mechanism, this time for N = 3 and N = 5. These values of N have the advantage of enabling the set of TPC commands which are concatenated for Algorithm 2 to be aligned to the frame boundaries. The simulation results presented here also take into account the effect of channel coding.

We conclude that the best results are obtained when N = 5. A revised text proposal is presented in [5].

2 Description of Simulations

The basic conditions are the same as in previous simulations:

2GHz carrier frequency
Pedestrian A channel
1 slot power control loop delay
AWGN TPC error 4%
SIR estimation error based on uplink SIR, using 6 pilot bits
No control channel overhead in Eb/No
Perfect Rake receiver
Ideal channel estimation
Physical channel rate 32kbps
AWGN interference

However, we now also take into account the effect of channel coding using the $^{1}/_{3}$-rate K=9 convolutional coder. This gives a coding gain of approximately 4dB after implementation losses, which corresponds to a raw channel BER of 0.13 for a BER after decoding of 10^{-3}.

When the BS requests the UE to use Algorithm 2, the UE does not change its transmit power until it has received N TPC commands.

If (and only if) all N TPC commands indicate a power change in the same direction, the UE then implements a 1dB power control step.

This method effectively enables the UE to emulate the use of a power control step of size 1/N dB.

3 Results

Simulation results are presented here to cover a wide range of relatively high UE speeds, where conventional power control is unable to track effectively the fast fading of the channel. It is under these conditions that emulation of small power control steps gives the greatest benefit, as shown by the comparison with "Algorithm 1" in the tables below.

Some benefit may also be gained at very low speeds, although the gain is not very significant at such speeds.

100km/h

Method	Received Eb/No (dB) required for BER = 1e-3 after channel coding	Transmitted Eb/No (dB) required for BER = 1e-3 after channel coding	SIR variance (dB^2) at BER = 1e-3 after channel coding
"Algorithm 1" (1dB step)	5.0	5.7	18.4
"Algorithm 2", N=3	4.8	5.2	17.1
"Algorithm 2", N=5	4.7	5.0	16.5

Improvement in Received E_b/N_0 achievable using Algorithm 2 and N=5 is **0.3dB**.

300km/h

Method	Received Eb/No (dB) required for BER = 1e-3 after channel coding	Transmitted Eb/No (dB) required for BER = 1e-3 after channel coding	SIR variance (dB^2) at BER = 1e-3 after channel coding
"Algorithm 1" (1dB step)	5.1	5.5	19.5
"Algorithm 2", N=3	4.7	5.1	16.7
"Algorithm 2", N=5	4.6	5.0	16.3

Improvement in Received E_b/N_0 achievable using Algorithm 2 and N=5 is **0.5dB**.

Algorithm 2 power control can also be used to enable the BS to turn off power control on the uplink without extra signalling. This could be useful for stationary terminals, for example. If the BS were deliberately to transmit an alternating sequence of TPC commands, the UE would never

, June 1999

[5] TSGR1#7(99)b42 "*Text Proposal on Power Control*", Philips, August 1999