3GPP TSG RAN WG1 ***TSGR1#7(99)c25***
August 30 – September 3, 1999, Hannover, Germany

Agenda item:	**Ad hoc 9**
Source:	**Philips**
Title:	**Initial Transmit Power Level after Transmission Gap in Compressed Mode**
Document for:	**Discussion**

1 Introduction

In downlink compressed mode, no TPC commands are transmitted during the transmission gap in the compressed frame. This means that the transmit powers of the uplink DPDCH(s) and DPCCH are not changed during the transmission gaps.

After a transmission gap, the closed loop power control has to converge on the SIR target as quickly as possible.

The current working assumption (as in [1]) allows for two alternative modes of responding to TPC commands to be employed. The mode to be used is signalled by the network along with the other downlink compressed mode parameters. The choice of mode enables the best power control step size to be used for a few slots after each transmission gap to bring about rapid convergence.

In this paper we propose that the network should also be able to signal as a separate parameter to the UE the **initial transmit power level**, P_{resume}, which should be used in the first slot after the transmission gaps. In order to minimise the amount of signalling that would be required to do this, we suggest that P_{resume} should take one of two values:

1. P_{resume} = Transmit power at start of transmission gap

2. P_{resume} = Average transmit power over the 32 slots preceding the transmission gap. (In these simulations we use 16 slots per frame.) In calculating the average, the power of the slots in the compressed frame is weighted in inverse proportion to the power offset in the compressed frame.

In this way the value of P_{resume} can be signalled with just one bit along with the other compressed mode parameters.

In this paper we present simulation results which show that, for a wide range of UE speeds, there is a significant advantage in terms of E_b/N_0 by setting P_{resume} equal to the average transmit power over the 32 slots preceding the transmission gap.

2 Description of Simulations

The basic simulation conditions were as follows:

2GHz carrier frequency
Pedestrian A channel
1 slot power control loop delay
AWGN TPC error: 4% in normal mode; 7% in recovery period
SIR estimation error based on uplink SIR, using 6 pilot bits
No control channel overhead in Eb/No
Perfect Rake receiver
Ideal channel estimation
16 slots per frame
Transmission gap length 8 slots
Recovery period length 8 slots
Transmission gap positioned at end of compressed frame
Physical channel rate 32kbps
AWGN interference
Approx. 4dB coding gain from $^1/_3$-rate K=9 convolutional coder
Target BER after decoding = 10^{-3}

The power control step sizes and compressed mode power control modes used for different UE speeds are shown in the table of results.

According to the current working assumption, compressed mode power control mode 0 entails using the same power control mechanism as in normal mode during the recovery period after a transmission gap.

Compressed mode power control mode 1 entails using a larger step size than in normal mode for a certain number of slots after a transmission gap.

Compressed mode power control mode 1 was used for speeds up to 50km/h as this is the range of speeds over which this mode has been shown to be beneficial (e.g. in [2] and [3]). For this mode, a fixed recovery period length of 8 slots was used. Compressed mode power control mode 0 was used for higher speeds.

3 Simulation Results

The following table of simulation results relates to the period of 8 slots immediately following each transmission gap.

The required values of received E_b/N_0, transmitted E_b/N_0 and SIR variance are shown for a target BER of 10^{-3} after channel coding.

UE speed / km/h	P(resume)	Normal mode step size / dB	Recovery period power control mode	Rx'ed Eb/No / dB	Tx'ed Eb/No / dB	SIR variance / dB^2
3	Norm	1	1	3.7	7.4	7.0
	Av	1	1	3.8	7.1	7.7
10	Norm	1	1	4.2	6.9	10.9
	Av	1	1	4.4	6.6	12.8
20	Norm	1	1	4.6	6.7	14.1
	Av	1	1	4.5	6.4	13.2
40	Norm	2	1	5.5	7.5	20.2
	Av	2	1	5.1	7.1	17.2
60	Norm	2	0	5.4	6.7	19.5
	Av	2	0	4.9	6.2	15.9
100	Norm	1	0	5.1	5.7	18.0
	Av	1	0	4.8	5.4	16.0
300	Norm	1	0	5.1	5.5	19.5
	Av	1	0	4.9	5.3	18.2

Figure 1: Comparison of performance in recovery period using normal and average transmit power levels after transmission gaps

Note: P_{resume} = Norm implies that the intial transmit power in the first slot after a transmission gap is equal to the transmit power in the last slot before the transmission gap.

P_{resume} = Av implies that the initial transmit power in the first slot after a transmission gap is equal to the average transmit power over the 32 slots immediately preceding the transmission gap, weighted as explained section 1.

It can be seen that the required E_b/N_0 and the SIR variance can be significantly improved over a range of UE speeds by recommencing transmission using an average power level instead of the power level used before the transmission gap.

The benefits are summarised in the following graphs:

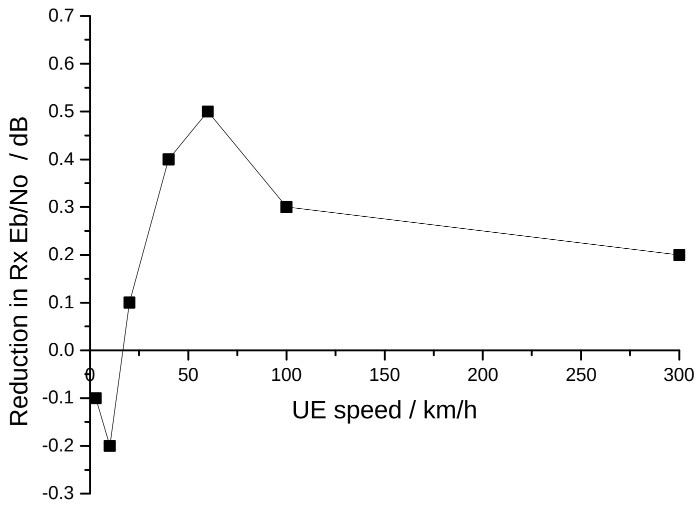

Figure 2:Improvement in recovery period Eb/No given by using average power after transmission gaps

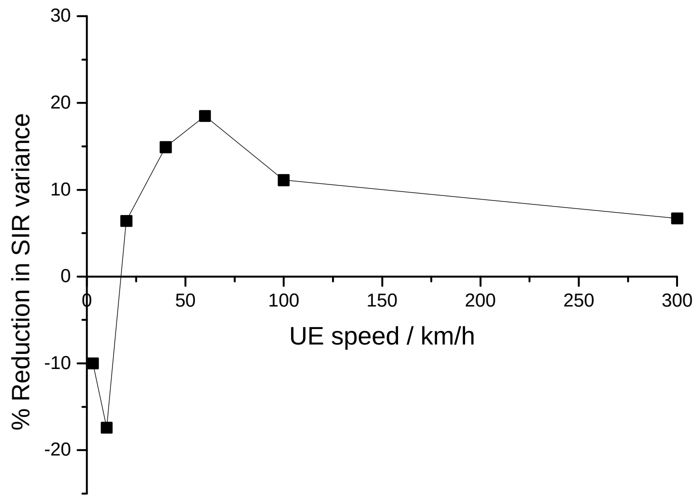

Figure 3: Improvement in recovery period SIR variance given by using average power after transmission gaps

A rather more general solution would be to allow P_{resume} to take a value based an offset with respect to the previous power (or the average power). The results presented above apply for an offset value of zero. However, this may not be the best value. Further work would be desirable to explore this possibility and also to assess the impact of different transmission gap lengths.

4 Conclusions

The current text on power control in compressed mode provides no indication of the initial transmit power level which should be used by a UE on resuming transmission after a transmission gap in compressed mode.

The simulation results presented in this paper show that, for a wide range of UE speeds, it is possible to achieve a significant improvement in E_b/N_0 and SIR variance during the recovery frame if transmission resumes at the average power level of the 32 slots preceding the transmission gap, rather than at the same level as the last slot before the transmission gap.

We propose that the relative power level for resuming transmission after transmission gaps in compressed mode should be signalled to the UE along with the other compressed mode parameters. This parameter should take one of 2 values, as follows:

1. P_{resume} = (Transmit power at start of transmission gap) +

2. P_{resume} = (Average transmit power over the 30 slots preceding the transmission gap) + , where the average should be weighted for those of the 30 slots which are in the compressed frame so as to cancel the effect of the power offset in the compressed frame.

The value of could be zero or some other offset and further simulations would be needed to verify the optimum value.

We propose that the initial power after the transmission gap in compressed mode should be specified in the way outlined above.

5 References

[1] TSGR1#6(99)a69 TS25.214 v1.1.1

[2] TSGR1#6(99)822 *"Optimum Recovery Period Power Control Algorithms for Compressed Mode"*, Philips, July 1999

[3] TSGR1#5(99)542 "*Additional results for fixed-step closed loop power control algorithm in compressed mode"*, Alcatel, June 1999