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Agenda item: Ad Hoc 1

Source: Siemens

Title: Power adaptation for TDD dependent on spreading

Document for: Discussion

Introduction

In [1] it is described how the rate matching is calculated dependent on the number of bits to be transmitted on each transport channel. Also the spreading factor of the required physical channels is addressed, which is maximised with respect to the amount of data bits in each frame, whereas the number of required physical channels is minimised.

By changing the transmit power with the change in the number of bits transmitted, the bit error rate approximately will remain constant and the inter-cell interference will be reduced. As an additional advantage, reducing TX power for those TFC with a high repetition rate the battery life could be preserved.

However, up to now it is not specified how the transmit power can be adapted when the spreading factor is changed or when puncturing or repeating of certain bits is applied.

Therefore, in the following simulation results are presented, which show the effect of spreading on the required bit energy. By evaluating those results, a simple algorithm for changing TX power dependent on the spreading in the current frame is proposed.

Although the same effect has to be considered for FDD as well, the presented results are TDD specific, taking into account the specific burst structure, where both, the midamble and the data parts are always transmitted with the same power level.

Simulation Results

Figure 1 shows the absolute raw bit error rate dependent on the applied repetition factor for the two channel models case 1 and 3, as specified in [2] annex B, compared to an AWGN channel. In all cases, no power control has been applied and the interleaving was set to 20 ms. Furthermore, the repetition factor has been varied over a large range to study the effect on the bit energy.

Since the midamble is a fixed bit pattern and is not subject to spreading, there is a minimum transmit power, which is needed for an error-free channel estimation. As can be seen, there is a clear saturation of the minimum energy for the AWGN channel as well as for the channel model 3, which refers to a vehicular case with a velocity of 120 km/h. For these channels the required E_b/N_0 is low enough to reveal the limiting effect of the midamble.

Case 1 refers to an indoor environment, where a strong fading effect appears and therefore, a much higher transmission power is needed. Here, the possible decrease of that power for higher repetition factors is more evident, since the additional redundancy reduces the sensibility to fading. Moreover, the presented results shows that the fading has a stronger effect on the data parts than on the midamble, since the difference in required bit energy between the three channel models becomes lower for very low code rates where the midambles limits the performance.

To evaluate this behaviour in more detail, in figure 2 the possible decrease of the raw bit energy is depicted again dependent on the spreading factor, but now using a logarithmic scale.

For all three channel models the behaviour is almost linear at low repetition factors. In case of AWGN and case 3, a saturation can be observed at high repetition factors. The highest repetition gain is about 24 dB, which occurs if only one data bit has to be transmitted within a full data burst of 244 bits assuming the maximum spreading factor of 16 and burst type 1. Since for case 1 the begin of the saturation zone is beyond this border of 24 dB, no saturation can be observed.

While the basic behaviour is the same for all three channels considered in this paper, there is a clear difference regarding the total amount of possible power reduction. As can be seen in figure 2, the strongest effect occurs with channel case 1, where a possible reduction of transmit power up to 10 dB can be observed.

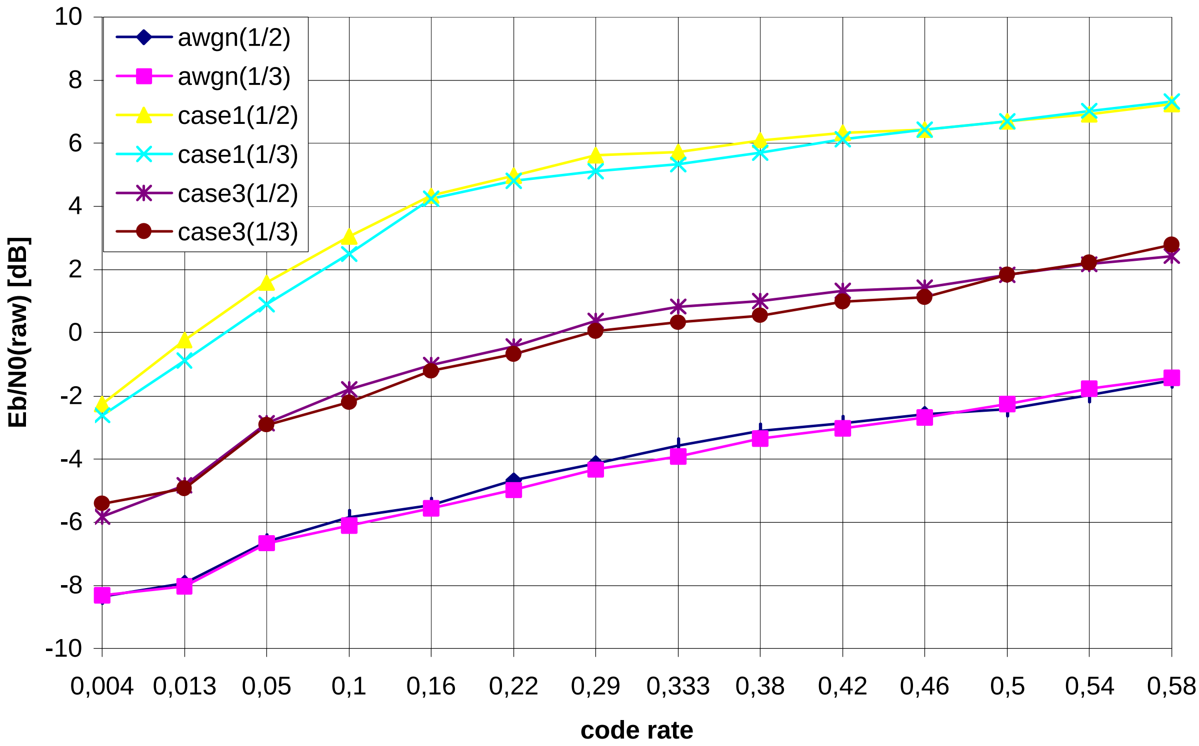

Figure 1: Required raw E_b/N_0 dependent on the code rate for a AWGN channel in comparison to case 1 and 3

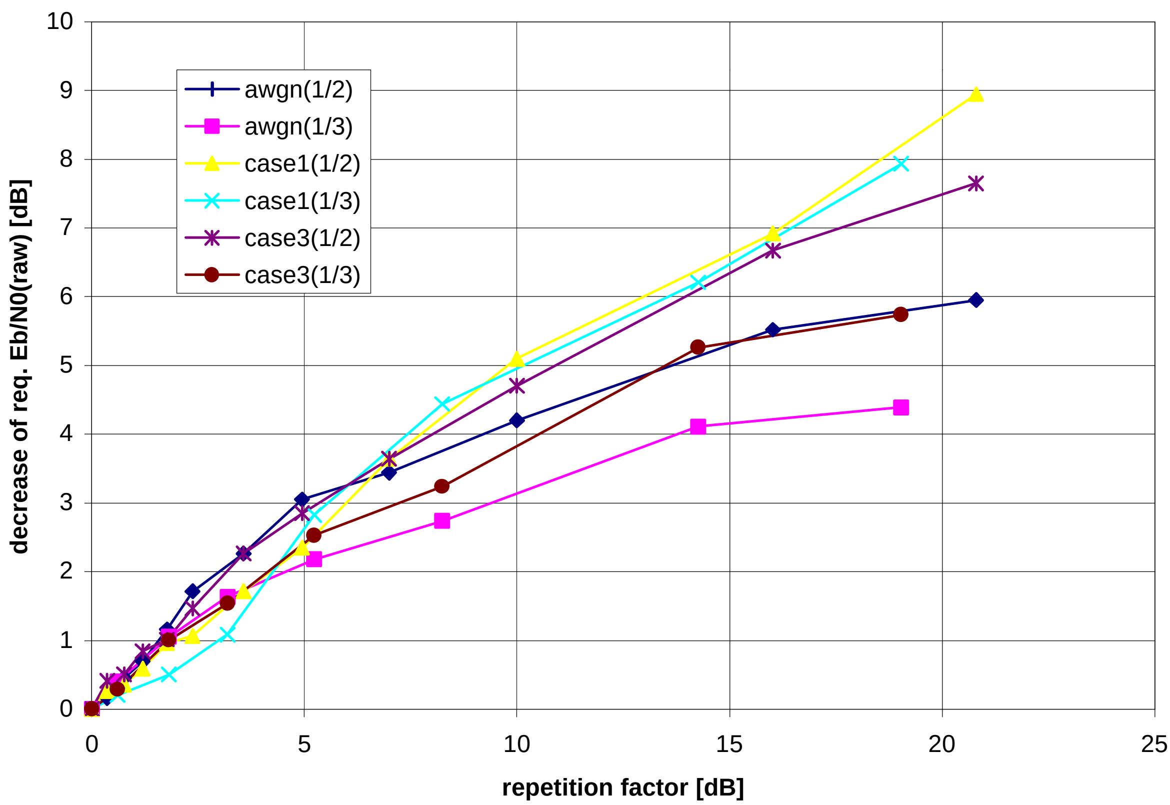

Figure 2: Possible decrease of raw E_b/N_0 dependent on the repetition factor for different channel models

Proposal for power adaptation

Figure 3 exhibits the proposed dependency of transmit power P with respect to the applied spreading S. The point (0, 0) refers to that bit energy, needed to transmit a reference TFC with the required BER.

In case of puncturing down to the puncturing limit PL, a linear reduction of power is appropriate as indicated by the curve with a constant slope of 1for S below 1. Since normally PL will be set to a value around 0.8 (-1 dB), this linear approach is justified, since in this range no degradation of the performance due to puncturing could be observed.

As outlined before, repetition is needed to be changed in a much wider range than puncturing. Therefore, we propose a non-linear behaviour in this region, which can be realised e.g. by a simple algebraic equation Starting with a slope of 1 at the reference point (0,0), the function and with it the decrease of TX power should saturate as the repetition goes to infinity.

In comparison to a possible alternative solution, which would be to simply define a look-up-table including ΔP in certain steps depending on spreading, the proposed functional description has the advantage of very low signalling overhead, in order to adapt the algorithm to different channel behaviour. In this case, only one parameter (ΔP_{min}) has to be signalled to each mobile, whereas the alternative solution would require the transmission of a whole table.

In any case, for the actual adaptation of TX power, a step function is applied, which guarantees that the power changes exhibit a predefined granularity.

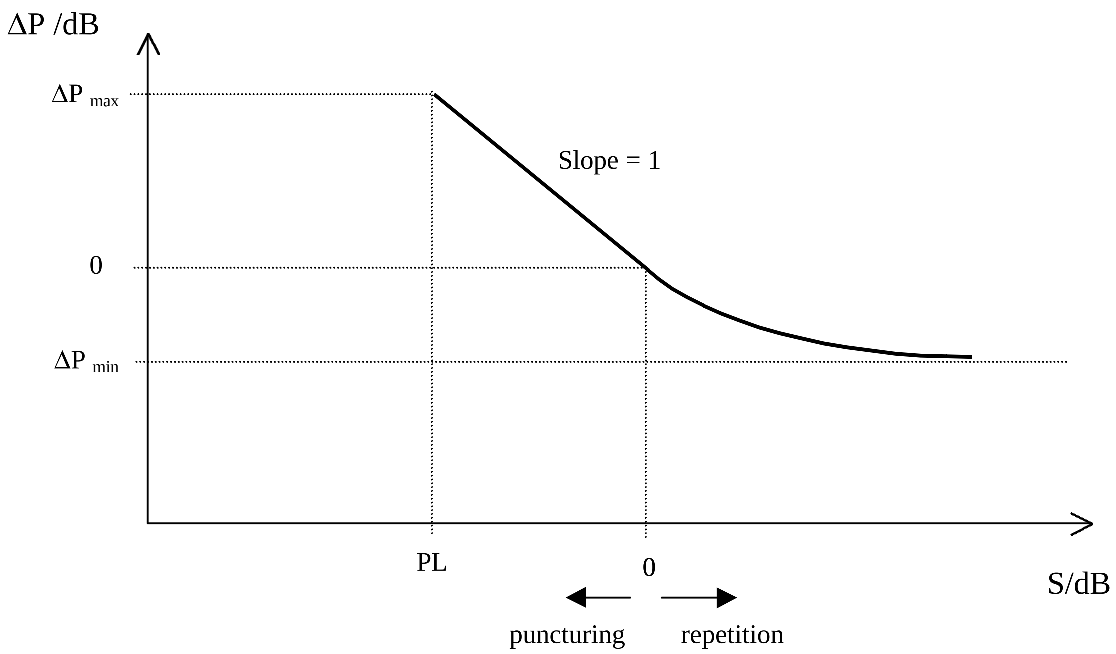

Figure 3: Proposal for changing the transmit power dependent on the applied spreading

Conclusion

In this paper, simulation results are presented, which exhibit the clear advantages of adapting the transmit power with respect to the spreading. Based on these results, a simple scheme for power adaptation is presented, which can be adapted to different channels with low signalling overhead. By applying the proposed algorithm, a reduction of TX power up to 10 dB can be achieved.

References

[1] TSG RAN WG1, “TS 25.222 Multiplexing and channel coding (TDD)”, V3.1.0

[2] TSG RAN WG4, “TS 25.102 Radio Transmission and Reception”, V3.1.0