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Title: Improvement of convolutional coding scheme for very low code block size

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Introduction

The problem of channel coding for very low code block sizes was already addressed in [1] and [2]. Indeed, WG1 must provide channel-coding means for code block sizes ranging from 1 to 5114 bits. However, neither turbo-coding, nor convolutional coding are adapted to very low code block sizes (<10 bits).

With convolutional coding of rate 1/n (n=2 or 3) and constraint length K=9, the effective coding rate taking into account the (K-1) tail bits is

$$R = \frac{N}{n(N+K-1)}$$

when the code block size is N bits. When N is very small, e.g. N=3, this rate becomes very low, i.e. R=1/11 for n=3 and R=3/22 for n=2. Thus, more power is used to transmit tail bits rather than information bits. This too large tail bit overhead will have detrimental effect on the link-level performance.

To address this problem, [2] proposes to use puncturing at both ends of the code block. This method enables to optimize performance but with increased coding complexity and it was not accepted so far.

In this contribution, we propose a sub-optimal method that enables to improve convolutional coding for very low block sizes without additional complexity.

Proposal

Tail bits enable to end the convolutional encoder in a known state (all-zeros state) and thus to avoid that last bits of the code block are significantly less protected than the others. The first bits are also more protected than the others since the convolutional coder begins in a known state.

However, for very low block sizes (N < K), the additional protection enabled by the known initial state already applies to the N bits. Thus, the extra-protection that the tail bits could enable is not needed anymore. In other words, there are now only 2^N possible final states instead of 2^{K-1} and thus a lower number of tail bits is sufficient.

Therefore, we propose to simply decrease the number of tail bits for very low block sizes. A compromise has however to be found between the number of tail bits and the resulting coding rate in order to preserve most of the performance achieved for higher block sizes. Thus, we propose to still keep a few tail bits, more precisely:

$$N_{tail} = \min(K-1, N)$$

where N is the code block size.

This solution enables to avoid that the coding rate be larger than 1/2n and thus avoid wasting too much power to transmit the tail bits. This proposal does add any complexity in the convolutional encoder and decoder.

References

[1] 3GPP R1-99g46, “Proposal for channel coding scheme for small block sizes”, October 99, Nortel networks

[2] 3GPP R1-99J08, “End puncturing for short convolutional codes”, December 99, Siemens