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STUDY GROUP 15 Original: English

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Question: 4/15

SOURCE[1]: VOCAL Technologies Ltd.

TITLE: G.gen: G.vdsl G.dmt.bis: G.lite.bis: A configurable multilevel/full turbo encoder with 4, 8 or 16 state convolutional encoder in single, double or triple turbo coder configurations

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ABSTRACT

The present paper relates to a technique for implementation of a general configurable encoder that allows the following modes of operation: no coding (NC), Trellis Code Modulation (TCM), full turbo code (FTLC), multilevel turbo code (MTLC), in single, double or triple turbo encoder configurations, using 4, 8 or 16 state convolutional encoders, interleaver sizes as an integral number of DMT symbols, and assignment of parity/information bits for greater protection with QAM modulations in a DMT system.

1. Introduction

The present paper relates to a technique for implementation of a general configurable encoder that allows the following modes of operation: no coding (NC), Trellis Code Modulation (TCM), full turbo code (FTLC), multilevel turbo code (MTLC), in single, double or triple turbo encoder configurations, using 4, 8 or 16 state convolutional encoders, interleaver sizes as an integral number of DMT symbols, and assignment of parity/information bits for greater protection with QAM modulations in a DMT system.

With this technique it is possible to choose:

How many bits will be encoded (0, 1, 2,…all)

Which bits are more protected (parity or information bits)

How many states used in the convolutional encoder (4, 8 or 16)

How many convolutional encoders are used (one, two or three)

How many DMT symbols is the size of the interleaver (1 to n).

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2. Description

This technique is presented in a general way, such as it shown in Figure 1, for Concatenated Convolutional Codes (CCCs).

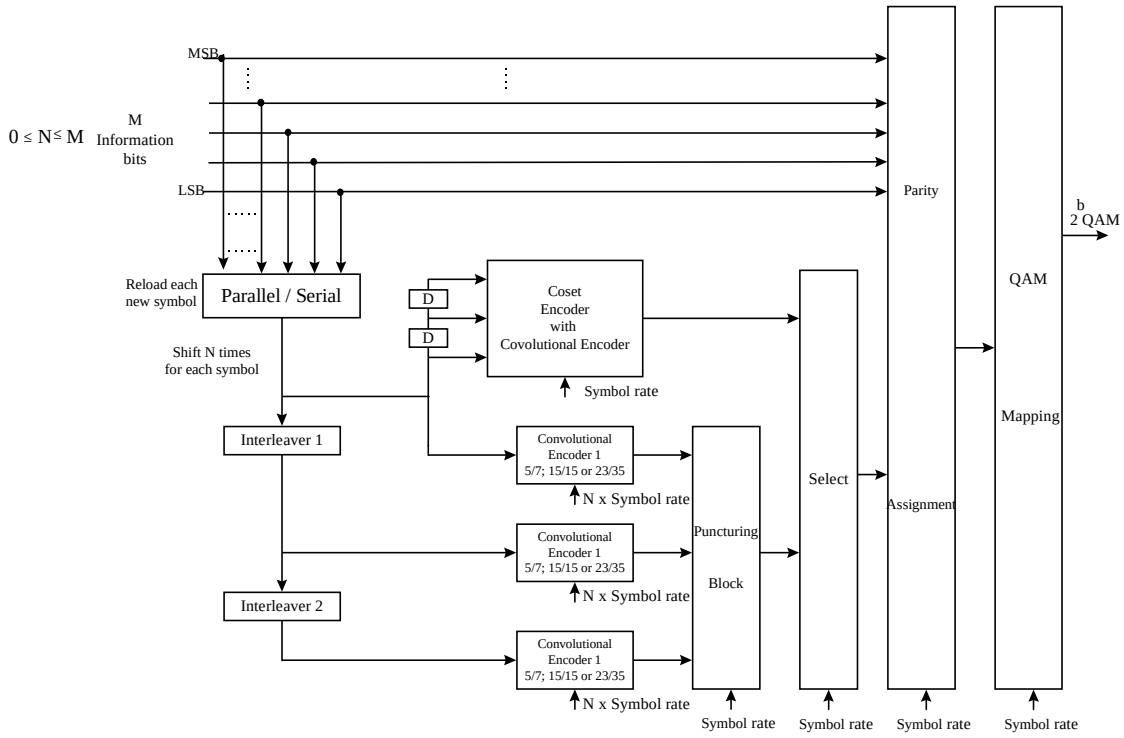

Figure 1. Block Diagram for the General Structure of CCCs

In this block diagram the bits are sent to the Parallel/Serial block every symbol. The Coset encoder, that includes its Convolutional Code defined in G.992.1, runs at symbol rate and produces the cosets bits defined in G.991.1.

The Convolutonal Encoders run at N times the symbol rate, where N is the number of information bits been encoded, and produce the parity bits. These parity bits go to the Puncturing block that decides which parity bits are used.

The Select block decides which encoder scheme is used (NC, TCM, FTLC-PCCC, MLTC-PCCC,etc...) assuming that all encoders run for each symbol, such as in a hardware implementation. An alternative technique for selecting which encoder scheme is used is to operate those required, such as will be done in a software implementation. .

The Parity Assignment block decides which bits are more protected, depending of the application. Providing more protection to the information bits, means that in the mapping, the probability of the information bits having an error is lower than the probability of the parity bits having an error. Providing more protection to the parity bit(s), means that in the mapping, the

probability of the parity bit(s) having an error is lower than the probability of the information bits having an error. For applications with a target BER below 10^{-7} in an AWGN (Additive White Gaussian Noise) channel, it is better to protect more the parity bits. For applications with a target BER higher of 10^{-7}, the protection of the information bits is more important in an AWGN channel. For Impulse noise channels, the greater protection of parity bits provides better performance in all cases.

The QAM mapping block maps the bits to the transmitted symbol.

The Puncturing, the Select, the Parity assignment and the QAM mapping blocks run at the symbol rate.

In the case that both Intelavers are used, the first Convolutional Encoder can be set to 4 states, the second and third Convolutional Encoder to 8 states, providing good performance.

In the case that the second interleaver is not used, if the first Convolutional Encoder and the second Convolutional Encoder are set to 8 states the performance is good for high order constellations, such as 8,10 or 12 bits. For lower order constellations, such as 6 bits, the use of 16 states convolutional encoder can provide an extra coding gain of 1.8 dB. The performance with 4 states is poor.

3. Summary

The present paper relates to a technique for implementation of a general configurable encoder that allows the following modes of operation: no coding (NC), Trellis Code Modulation (TCM), full turbo code (FTLC), multilevel turbo code (MTLC), in single, double or triple turbo encoder configurations, using 4, 8 or 16 state convolutional encoders, interleaver sizes as an integral number of DMT symbols, and assignment of parity/information bits for greater protection with QAM modulations in a DMT system.

1. Agenda Item: G.992.1.bis issue 4.6 and G.992.2.bis issue 10.14. G.vdsl issue 11.17
2. Expectations: The committee accepts the technique described in this paper.