Fraunhofer Institut Integrierte Schaltungen

Memo

Subject: Proposal for Puncturing Pattern for 3/8 code

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1 Scope

The split 3/8 convolutional code is subject of analysis within WP21B. This memo includes a proposal for the convolutional code and the puncturing pattern.

2 Problem

The new proposal for diversity combining introduced by FhG is based on a convolutional code with a mother code of code rate 1/3. If both satellite signals are available the received pattern is equivalent to a system with code rate 1/3. If only one signal available the received signal is equivalent to a punctured convolutional code with a remaining code rate of ¾.
A code rate of ¾ is typically derived from a mother code of code rate ½. For our system for a mother code of code rate 1/3 two puncturing patterns for the early and late signal must be found.

3 Status/Proposals

STEL has analyzed some puncturing patterns by simulation and made some proposals. The proposals are based on the polynomials

G1 = 171 (Octal)

G2 = 133

G3 = 165

This polynomials are identical to the polynomial supported by the Qualcomm chip Q1650 [3]. The puncturing pattern for code rate ¾ is:

1 0 1

1 1 0

(G3 is used for code rate 1/3 only. For codes with code rate <= ½ G3 is not used.

The Eureka 147 standard uses the following polynomials:

G1 = 133(Octal)

G2 = 171

G3 = 145

G4 = 133

For these polynomials puncturing patterns from code rate 8/9 to ¼ are given. The details of the puncturing patterns can be found in [2]. The Eu-147 does not define a puncturing pattern for code rate ¾. Only patterns for 8/11 = 0.7272 and 8/12 = 0.8 are given. The puncturing pattern for 8/11 is:

1 1 1 1 1 1 1 1

1 0 1 0 1 0 0 0

For 8/10:

1 1 1 1 1 1 1 1

1 0 0 0 1 0 0 0

is specified.

FhG did together with the University of Erlangen (Prof. Huber) some literature analysis. The paper [1] give an very good overview to different puncturing patterns. Based on this paper the following proposals can be derived:

Generator polynomials:

G1 = 147 (Octal)

G2 = 135

G3 = 163

Puncturing pattern

E E E

E x L

L L L

This is equivalent to using a code with the polynomial 163,135 for the satellite 1 and a code with the polynomials 147, 135 for satellite 2 and the puncturing pattern

1 1 1

1 0 0

as proposed by [1]. According to the literature both codes are "best" ¾ codes. At least the code with the polynomials 147 and 135 generates a good code for code rate ½ also. Therefore this code can be used for terrestrial also. The performance of the total 3/8 code is TBD (e.g. by simulation). [1] does not give results for this combination.

Please note: Using this proposal may give a slightly better performance then the current used polynomials.

4 Other Options

All the given proposals are based on a constraints length of K = 7. Optional other constraint length (e.g. K = 8 or K = 9) can be considered providing an additional gain. A higher constraint length adds additional complexity to the chipset (additional cost is app. 1$). If a significant improvement can be achieved the additional complexity is acceptable.

Literature

[1] J. BIBB CAIN, George C. Clark and John M. Geist
Punctured Convolutional Codes of Rate (n-1)/n and Simplified Maximum Likelihood Decoding.
IEEE Transactions on Information Theory, VOL. IT-25, Mo. 1, January 1979

[2] ETS 300 400 1: Digital Audio Broadcasting (DAB) To Mobile, Portable and Fixed Receivers

[3] Q1650 K=7 Multi-Code Rate Viterbi Decoder, Data sheet QUALCOMM Incorporated,
VLSI Products