

SOURCE<sup>1</sup>: CopperGate CommunicationsTITLE: G.hn: Using Two Symbols for the Header of a PHY frame on Coax

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**ABSTRACT**

The contribution proposes that the number of symbols used for the header of the PHY frame on coax (baseband and RF) be fixed to two exactly. The reason for this proposal is that a single symbol does not provide adequate reliability for the 50 MHz case, as shown below.

**1. Introduction**

The PHY-header of a PHY-frame is defined in G.9960 [1] to contain important information necessary in order to process the payload. The information of the header is encoded in a single FEC block of 168 bits with code rate 1/2. This information is modulated onto either one or two OFDM symbols using QPSK modulation. The effective number of repetitions depends on the number of active subcarriers and on the number of header symbols (1 or 2).

It is not specified what the conditions for choosing one or two symbols are. The intention is that there will be a sufficient number of repetitions of the FEC block so that some minimum level of robustness is guaranteed.

A straightforward calculation can be carried out in order to assess the required number of OFDM symbols. Let us consider the more challenging setting of 50 MHz devices on coax. Both for baseband and RF, the number of subcarriers is 256. Since the header is modulated using QPSK and rate 1/2 a single copy of the PHY-header FEC block takes 168 subcarriers. Obviously, there is only room for a single complete copy of the FEC block. This situation is problematic, because the header does not have any advantage over the payload in terms of robustness.

Decoding a 136-bit FEC block with a BLER level of  $10^{-6}$  requires an SNR of 5 dB or so. On the other hand, decoding a 520-byte FEC block with a BLER level of  $10^{-6}$  requires an SNR of about 3.5 dB – some 1.5 dB less.

It is reasonable to approximate that if there are  $N$  copies of a FEC block then it acquires an extra coding gain of  $10\log_{10}(N)$ , even if  $N$  is non integer. If we assume that 0.9 of the band is utilized then this means there are  $256 \times 0.9 / 168 = 1.4$  repetitions per symbol, which provide a gain of 1.5 dB. This

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makes the header about as robust as a payload encoded using a FEC block of 520 bytes with code rate 1/2 and QPSK modulation.

This contribution proposes to *always* use two header symbols on coax. The number of subcarriers in two OFDM symbols is 512, which is barely sufficient to accommodate 3 full copies of the header, which require  $3 \times 168 = 504$  subcarriers. Note that in practice some guard bands are expected near the band edges. In this case, even 3 full repetitions will not fit in.

## 2. Proposal

It is proposed to incorporate the following text additions to [2] G.hn: Draft text for G.9960 Amendment 1 – version 4.0.

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### 7.1.3.4 Header encoder

The functional model of the header encoder is presented in Figure 7-10. It contains an FEC encoder and a Header Repetition Encoder (HRE).

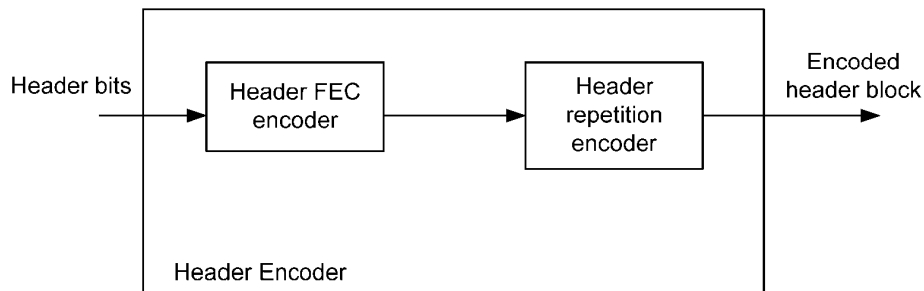


Figure 7-10/G.9960 – Functional diagram of the Header Encoder

The bits of the PHY-frame header shall input the Header FEC encoder in their original order and encoded as described in §7.1.3.2. The size of the FEC codeword and the coding rate of the Header FEC encoder are described in Table 7-19.

The FEC codeword enters the HRE. The HRE shall operate as follows:

- The FEC codeword shall be first copied  $M$  times, where  $M = \text{ceiling}(D \times k_H / N_{FEC})$ ,  $k_H$  is the number of bits to be loaded onto the OFDM symbol carrying the header, and  $D$  is the number of symbols to be used for header transmission
- The encoded header block shall be formed by concatenation of  $M$  copies of the header FEC encoder output. As each codeword is cascaded to one another, the bits ( $b_i$ ) within a codeword shall be cyclically shifted by 2 bits as follows:
  - The 1<sup>st</sup> FEC codeword copy shall be formed as  $\{b_0, b_1, \dots, b_{NFEC-2}, b_{NFEC-1}\}$ .
  - The 2<sup>nd</sup> FEC codeword copy shall be formed as  $\{b_2, b_3, \dots, b_{NFEC-1}, b_0, b_1\}$ .
  - The 3<sup>rd</sup> FEC codeword copy shall be formed as  $\{b_4, b_5, \dots, b_{NFEC-1}, b_0, b_1, b_2, b_3\}$ .
  - ...

- The  $M^{\text{th}}$  FEC codeword copy, where  $M > 3$ , shall be formed as  $\{b_{(2 \times M - 2)}, b_{(2 \times M - 1)}, \dots, b_{N_{\text{FEC}} - 1}, b_0, b_1, \dots, b_{(2 \times M - 4)}, b_{(2 \times M - 3)}\}$ .

Valid values of  $D$  are either 1 or 2. Details for powerline and phoneline are for further study.

For coax (baseband and RF) the number of PHY-frame header shall be two, i.e.,  $D = 2$ .

NOTE: Since the coding rate used for header encoding is  $1/2$ , the number of bits in the FEC codeword is always even, and the number of bits in the encoded header block is even.

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### 3. References

- [1] G.9960 LC comment resolution draft text R7.doc "ITU-T Recommendation G.9960, Unified high-speed wire-line based home networking transceivers - Foundation", Editor for G.hn, Baltimore Maryland, 18 – 26 May 2009.
- [2] 09XC-R12a, "G.hn: Draft text for G.9960 Amendment 1 – version 4.0", Xian, China – 27 – 31 July 2009.

### 4. Summary

It is proposed to agree on the following new items.

New item 5.0.1.2.1.2.0.1	Open	Should the PHY-frame header include exactly two OFDM symbols for coax (baseband and RF)?	09XC-100
New item 5.0.1.2.1.2.0.2	Open	Should the text changes proposed in Sec 2 of 09XC-100 be adopted into 09XC-R12a?	09XC-100