Frame Overhead of HDLC vs. 64b/66b

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Abstract

- The issue raised after the January 2002 EFM meeting:
  - The HDLC Frame is unacceptable for EFM due to its unpredictable length. Another scheme is needed, the 64b/66bfor example, as used in 10G.

- In this presentation we study this claim.

HDLC Background

- HDLC Frame includes:
  - Opening Flag — 7E hex
  - Address field — FF hex
  - Control field — 03 hex
  - Information field — Original Ethernet Packet, 1522 octets max.
  - FCS — CRC16 (2 octets)
  - Closing Flag — 7E hex

- To avoid an Opening/Closing Flag within the Information field, HDLC uses Byte-Stuffing:
  - 7E hex $\Rightarrow$ 7D 5E hex
  - 7D hex $\Rightarrow$ 7D 5D hex
- Overhead= 6 Bytes (fixed) + Byte-stuffing (statistical)

HDLC Byte-stuffing probability

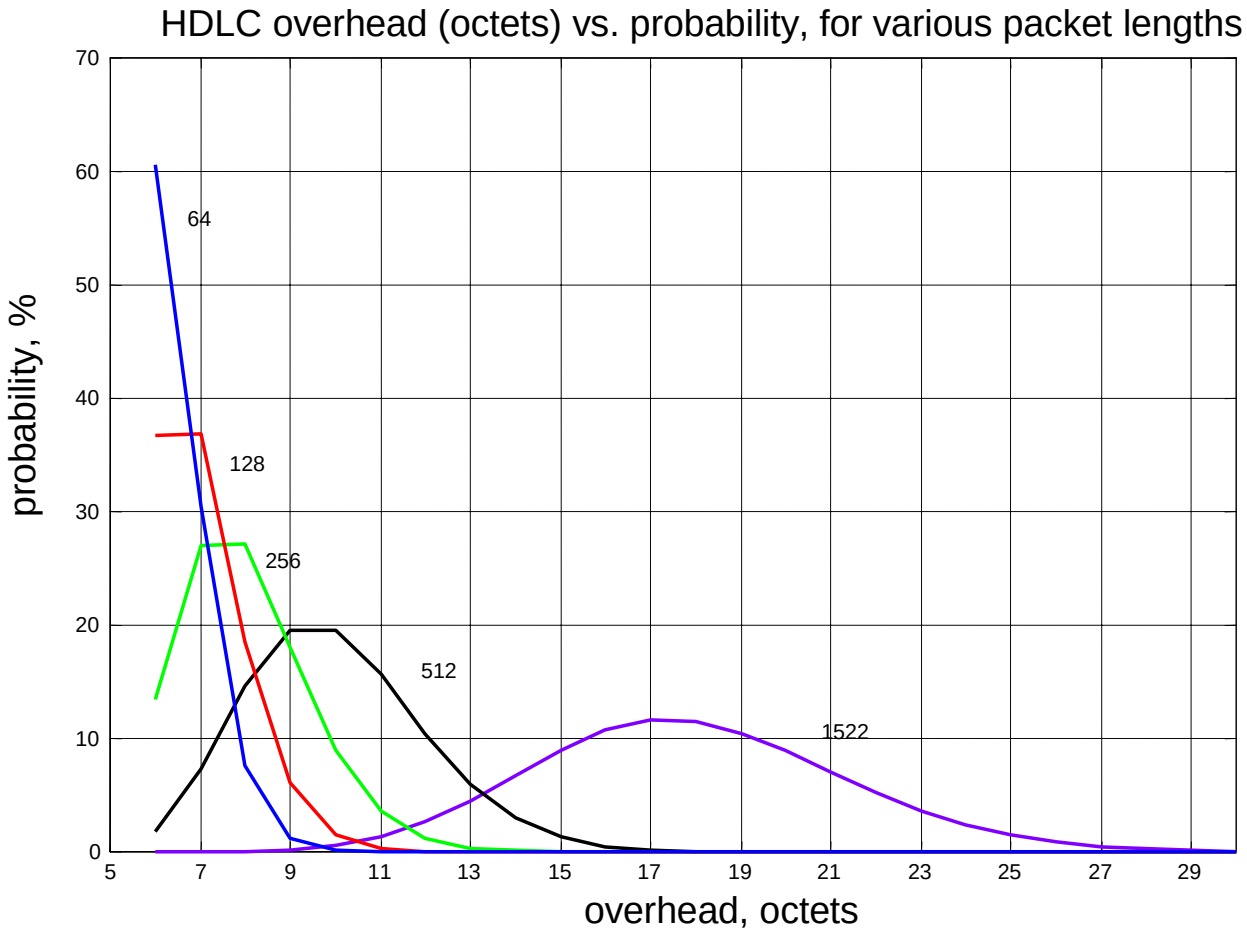
- Each appearance of 7E or 7D adds one Byte overhead to the packet.
- The probability for M appearances of 7E or 7D in a packet of length L:

$$P = \sum_{i=1}^{M} \binom{L}{i} \cdot P_1^{\,i} \cdot (1 - P_1)^{L-i}$$

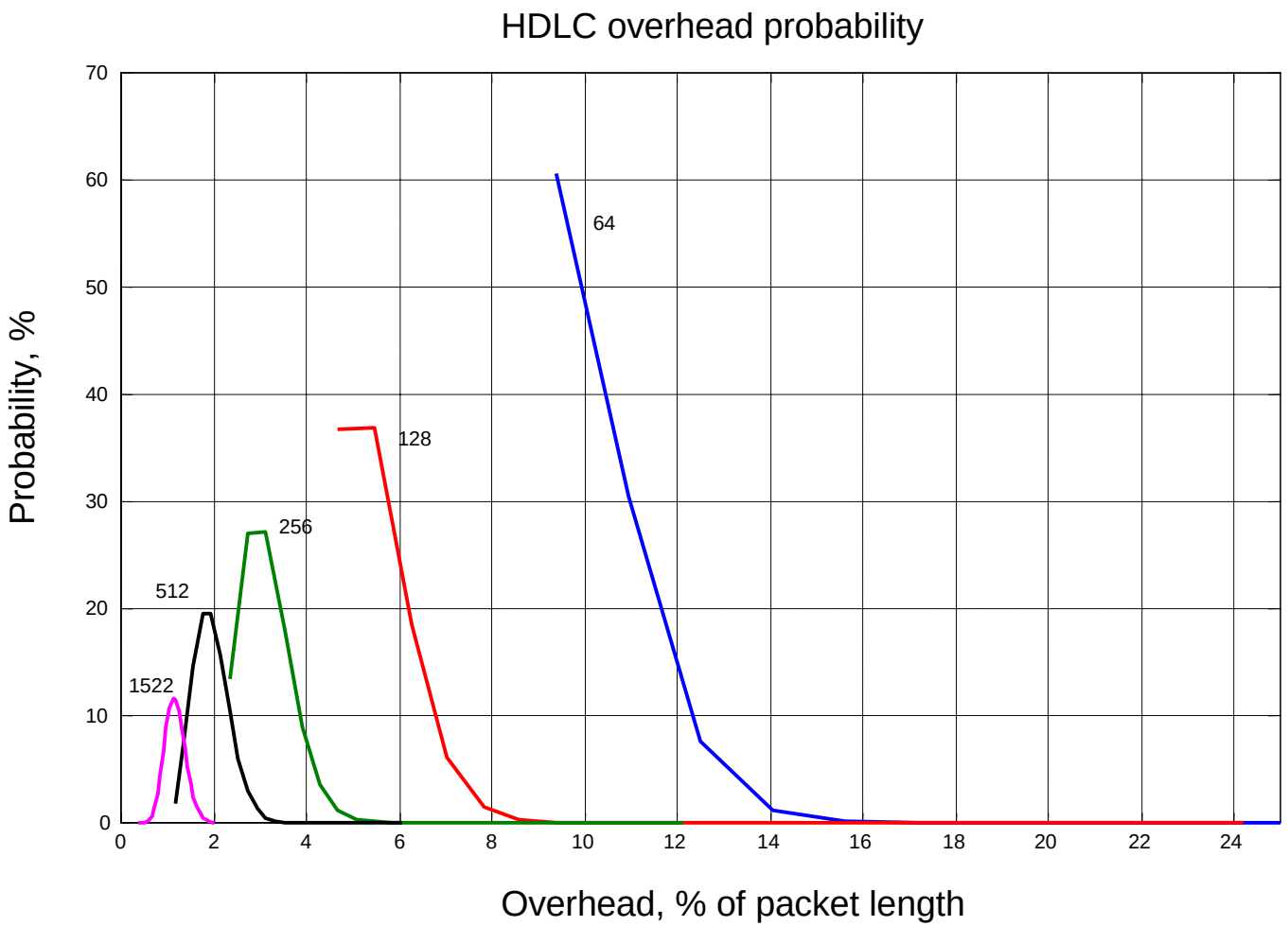
Where: $P_1 = 2 \cdot 2^{-8}$

- The fixed overhead ranges from 9.375% for shortest packet, to 0.3942% for longest packet.

HDLC overhead vs. probability (fixed + statistical)



Total HDLC overhead probability vs. % of packet length



64b/66b Code overview

- Each frame starts with a SOP flag, and ends with a EOP flag.
- Each frame is divided into 8-octet codewords.
- Data codeword, and Mixed Data/Control codeword.
- Data codeword has “01” sync preamble.
- Mixed Data/Control frames have
  - “10” sync preamble
  - Data octets
  - Control octets, as needed to fill a 64-bit codeword.

64b/66b Codeword structure

- S=SOP, T=EOP, Z=Control, D=Data
- Two possible SOP:
  - S D D D, D D D D
  - Z Z Z Z, S D D D
- Pure data:
  - D D D D, D D D D
- Pure control:
  - Z Z Z Z, Z Z Z Z
- Eight possible EOP:
  - T Z Z Z, Z Z Z Z
  - D T Z Z, Z Z Z Z
  - D D T Z, Z Z Z Z
  - D D D T, Z Z Z Z
  - D D D D, T Z Z Z
  - D D D D, D T Z Z
  - D D D D, D D T Z
  - D D D D, D D D T

64b/66b overhead

Taking all this together yields:

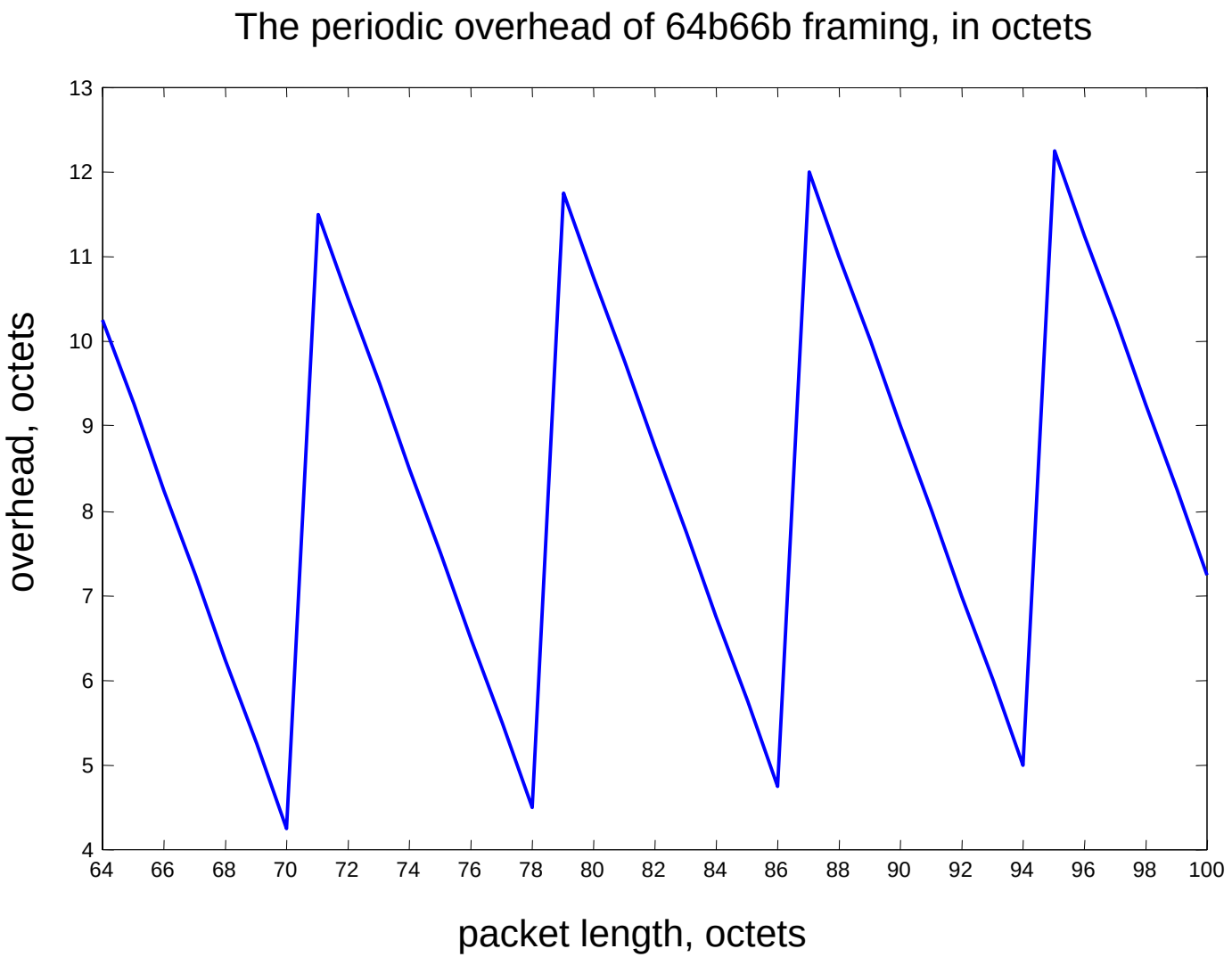
$$\Delta_L = ceil(\frac{L+2}{8}) \cdot (8 + \frac{1}{4}) - L$$

Where:

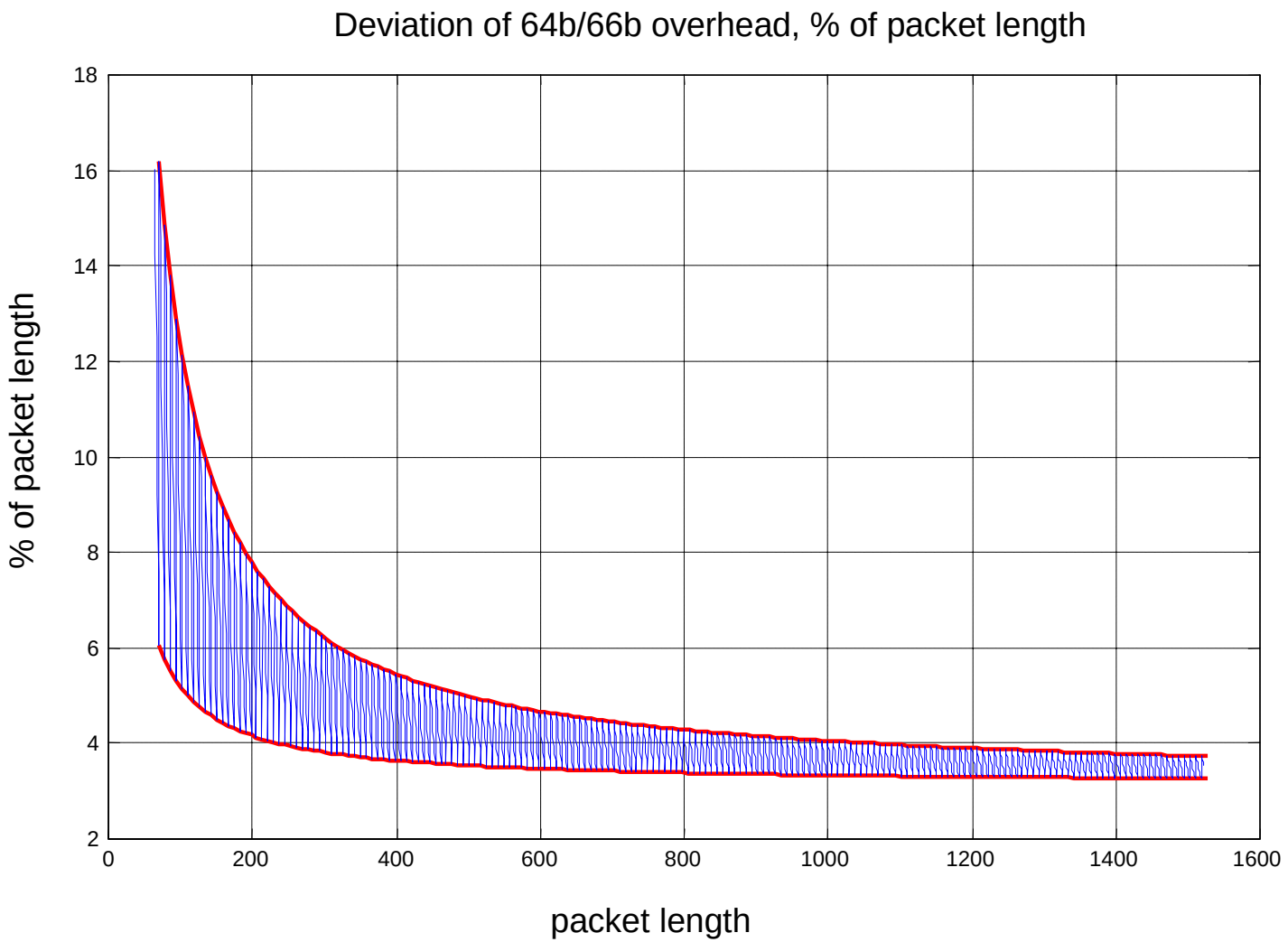
Δ_L **- is the overhead, in octets, best-case. For worst-case : need to add 4 octets, due to SOP alignment. Worst-case probability: 75%.**

L **- is the packet length, in octets.**

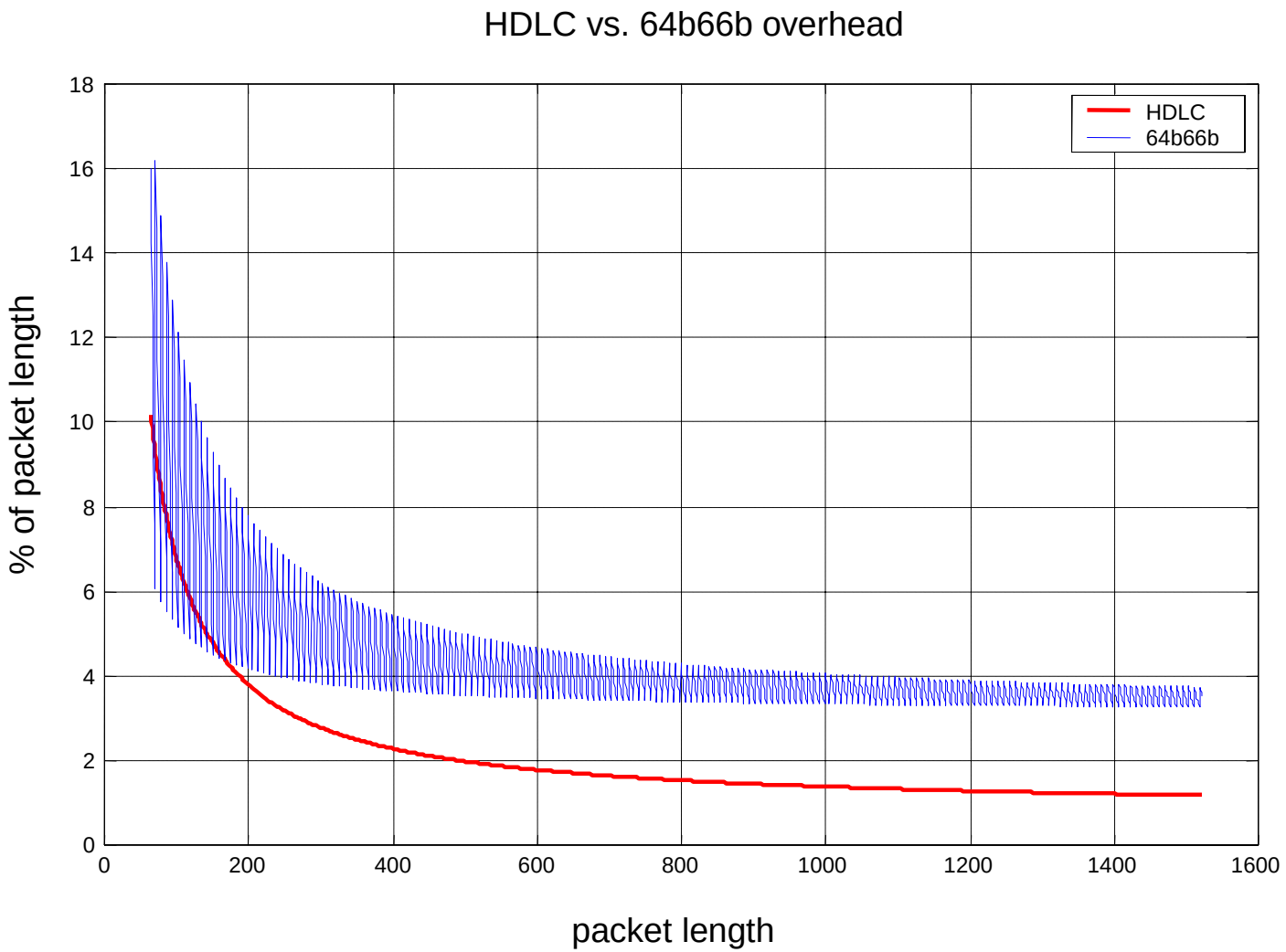
64b/66b Overhead in octets, Periodic behavior



Min. & Max. Overhead of 64b66b framing, in %



Average HDLC overhead vs. 64b66b overhead



Summary

- HDLC overhead is influenced by:
  - Control (6 octets, fixed)
  - Packet length (statistical Stuffing)
- 64b66b overhead is influenced by:
  - SOP & EOP (2 octets, fixed)
  - SOP alignment (0 or 4 octets, statistical)
  - Packet length modulu 8 (periodic behavior, up to 7 octets)
  - Preamble (0.25 octet per 8 octets of the new frame)
- Both framing schemes have fixed & statistical behavior of the overhead.
- Thus accurate prediction of packet length is problematic in either cases.
- The average HDLC overhead is lower than the 64b/66b overhead.