Encapsulation and Framing

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(some brief comments)
Definitions

• Encapsulation
  The technique used by layered protocols in which a layer adds header information to the protocol data unit (PDU) from the layer above.
  Used to identify the Start (and End) of packet – may add protection.

• Framing
  The definition of delimiters and contents for the protocol data unit (PDU).
  Defined for Ethernet and unchanged (in essence) for 15 years.

• Encapsulation != Framing
  In general the two are completely orthogonal.
  The MAC should not be able to detect the encapsulation.
Encapsulation Basics

Example system

(clocked at x-MHz)

Nibble Wide Data

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Separate Framing Signal(s)

(clocked at 5x-MHz)

\[
\begin{array}{c}
\text{4 clocks data} \\
\text{1 clock control}
\end{array}
\]

• Encapsulation achieved by clocking faster (25% overhead)
  Very fragile, susceptible to corruption, very hard to synchronize.

• Nobody would use this system in real life!
Encapsulation Options (1)

• **N** consecutive bits of data are encoded as an **m** bit codeword

  $2^n$ data codewords plus control codewords must be defined out of a possible $2^m$

  Codewords may be chosen to add protection against framing errors
  Control codewords may also carry data if required

• **Multiple variants used for Ethernet**
Encapsulation Options (2)

Substitution Codes

- Define an escape codeword, substitute occurrences of matching patterns in data stream
  - Very simple coding in use for more than 30 years
  - Causes data dependant variation in bit rate
  - May also be susceptible to framing errors
- Popular in modem standards
Encapsulation 64b/66b

- **Byte oriented control words:**
  - $2^{64}$ data only codewords
  - $2^{59}$ codewords for each control code
  - As used for 10Gig Ethernet
- **Overhead** = $2/64$ (≈3%) + at least 1 byte per frame (SOP)
Ethernet Framing

Framing is performed by the MAC

The PHY cannot change the framing

Defined in 802.3 – 3.1

= 96 bits
For all PHYs
Why not ditch the useless part?

• Neither preamble nor IPG is required for full duplex system
  Remove these parts to gain a (frame length dependant) increase in b/w
• More than 100,000,000 MAC devices already installed
  MAC must see unchanged framing
• High density (integrated MAC) silicon supports QOS
  Constant Bit Rate algorithms assume Ethernet framing preserved
• No Ethernet has changed this frame format (including IPG)
  What is Ethernet?
In Conclusion

- **Encapsulation**
  - Low overhead, fixed overhead – already defined for Ethernet.
  - 64b/66b is the clear choice.
  - Add CRC16 to increase protection (per Barry’s analysis).

- **Framing**
  - Preserve the whole Ethernet frame format – including preamble and IPG.
  - Supports all existing MAC devices.

- **Encapsulation + Framing**
  - Very similar to 10GigE.