EPoC PMA SERVICE INTERFACE PROPOSAL, PHY DATA RATES

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OVERVIEW

- **802.3 layer architecture separates the PCS and PMA sublayers using the PMA Service Interface:**
  - PMA_UNITDATA.request() for conveying information and status from the PMA_Client (PCS) to the PMA.
  - PMA_UNITDATA.indication for conveying information and status from the PMA to the PMA Client.
- **These are abstract layer interface and do not imply any particular implementation!!!!**
  - This interface will not be exposed as an external interface
- **These interfaces facilitate layer state diagrams and dependencies => for the standard**

EPoC UNIQUENESS

- **Our PHY data rate (both downstream and upstream) are based on cable operator's provisioning => principally spectrum (subcarrier) assignment and bit-loading.**
  - OFDM itself places other overheads that are algorithmically determined.
  - Variable, we are not a clock rate * word size based interface
- **Nothing is constant such as with other media; e.g. TP, fiber, etc.**
  - No octet or word granularity
- **On transmit, we are using 65-bit data groups going into an LDPC process that adds CRC40 and FEC Parity that then is processed by a bit scrambler**
  - Also, the symbol mapper takes a bit stream as an input
- **PMA service interface proposal in this presentation is bit granular**
- **Also, provisioning the PHY for octet, word, or other granularity is either NP-complete or severely reduces flexibility for the cable operator.**
  - Let them have maximum provisioning flexibility, let EPoC adapt around that

PMA SERVICE INTERFACE OVERVIEW

- **Draft text details in laubach_3bn_09_0914.pdf.**
- **Essentially, PMA_UNITDATA.request and PMA_UNITDATA.indication conveys data a bit at a time with two boolean flags: burstStart and burstEnd**
  - Flags set to TRUE at the appropriate bit, FALSE otherwise
- **Downstream transmission and reception is continuous stream of FEC_DS_CodeWordSize sized codewords. CLT FCP (NCP) function uses burstStart, symbol clock, and frame start to update FCP value in PHY Link.**
  - Note: CLT FCP (NCP) function needs to move to PMA to avoid layer violation
- **Upstream transmission and reception is a variable length burst containing one or more codewords. CNU symbol mapper uses burstStart and burstEnd for marker placement. CLT PCS receive uses burstStart and burstEnd to determine burst length.**
- **Nominal bit rate is CLT_DS_DataRate and CLT_US_DataRate**
  - Calculation overview follows later..

GEARBOX FUNCTIONALITY MAY NOT BE NECESSARY

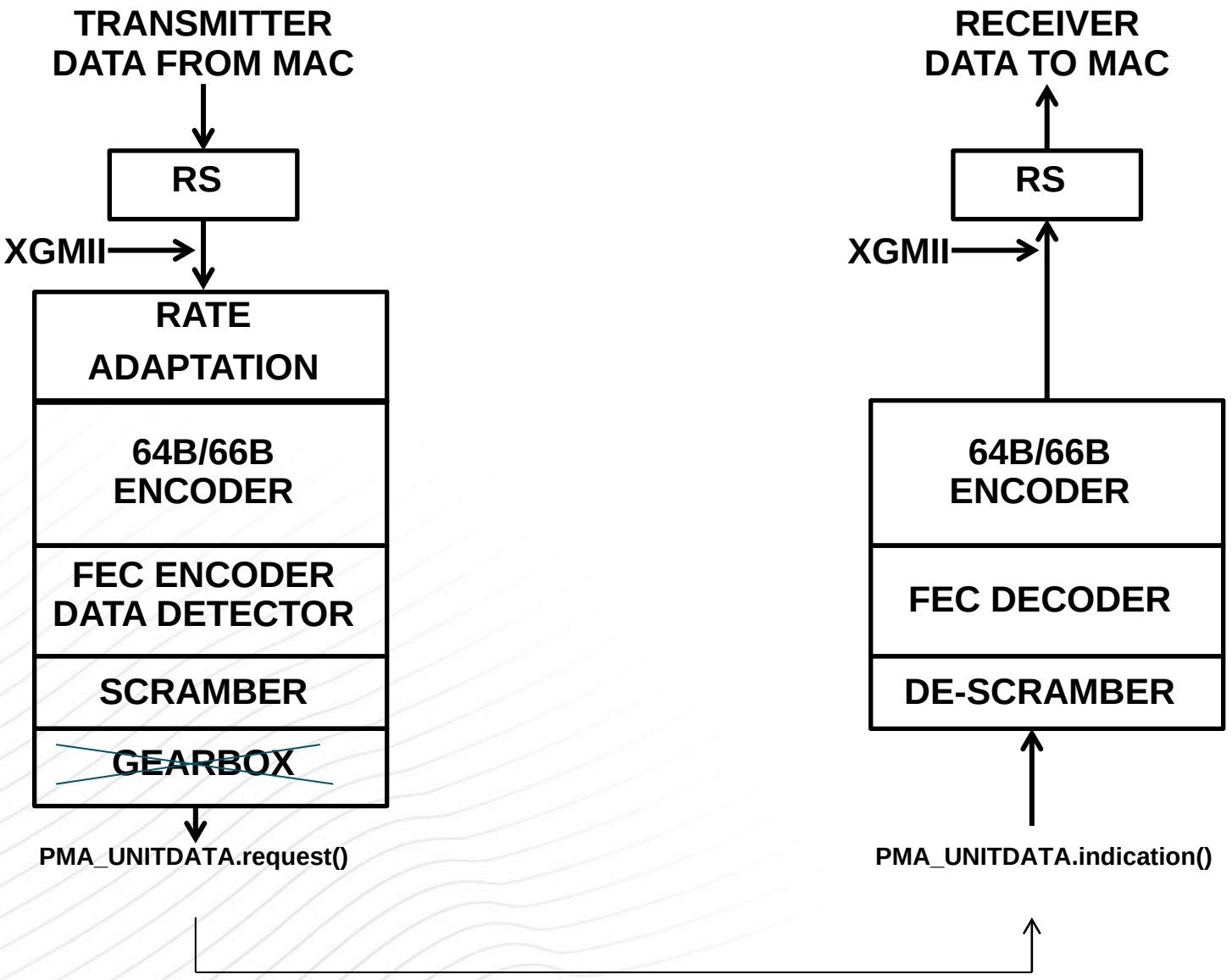
Observation:

- **Refer to last sentence of Clause 49.2.7 Gearbox:**
  - *Depending on the path width, the gearbox functionality may not be necessary*.

- **Given the EPoC PHY layers are bit granular, the scrambler output is a bit stream, having a bit-wide PMA Service Interface likely removes the need for a Gearbox function.**
  - There is no “16 bit of transmitted data unit” as is in other 802.3 standards
  - Our PCS burst (codeword) lengths are not multiples of 66-bits or 65-bits (if comment resolution is approved for this item).

- **Proposal: remove Gearbox function**

EPoC – BALANCED ARCHITECTURE



PMA DOWNSTREAM PHY DATA RATE

- **CLT_DS_DataRate**
  - Downstream PMA OFDM frame repeats every 128 symbols
    - DS_Frame_Length = 128 * Extended_OFDM_Symbol (seconds)
    - Extended_OFDM_Symbol = 20 usec + Cyclic Prefix Time (configurable)
  - Downstream DS_Frame_Data_Load (bits)
    - Calculated after (re)provisioning and insertion of pilots (See 101.4.2.8)
    - ∑ over 128 symbols ∑ bits per subcarrier, for each active subcarrier over all enabled lanes, containing data
      - Skip PHY Link, excluded subcarriers, continuous pilots and scattered pilots
    - DS_Frame_Data_Load has the same value every frame
  - CLT_DS_DataRate = (DS_Frame_Data_Load / DS_Frame_Length) (bits/sec)
    - This establishes nominal data rate for CLT PMA_UNITDATA.request() service interface
    - This does not include PCS overheads

CLT_DS_DataRate EXAMPLE

Subcarriers	Pilot Overhead	PHY Link Overhead	Subcarrier for Data	Bits per subcarrier	Bits per Symbol	DS_Frame_Data_Load
	(approximate)	subcarriers	(approximate)			bits / frame
3800	2.0%	8	3716	12	44592	5707776
Symbol Duration	Cycle Prefix	Extended Symbol	Frame Symbols	Frame_Length		
seconds	seconds	seconds		seconds		
0.00002	0.0000005	0.0000205	128	0.002624		
CLT_DS_DataRate = (DS_Frame_Data_Load / Frame_Length) =			2,175,219,512.20	(bits / second)		

Observations on Example:

1. Example includes no excluded subcarriers
2. Pilot overhead and Frame_Data_Load is approximate. Must be based on actual pilot placement over the entire frame.
3. Example shows same bits per subcarrier loading, will be based on cable operator provisioning.
4. Vendor's calculation method will be implementation dependent, answer should be the same when calculated on the CNU

PMA UPSTREAM PHY DATA RATE

- **CLT_US_DataRate**
  - Upstream PMA OFDMA frame repeats every 256 + Probe symbols
    - US_Frame_Length = (256 + P) * Extended_OFDM_Symbol (seconds)
    - Extended_OFDM_Symbol = 20 usec + Cyclic Prefix Time (configurable)
    - P = Probe symbols are either 5 or 6
  - Upstream Frame_Data_Load (bits)
    - Calculated after (re)provisioning and insertion of pilots (See 101.x.x.x)
    - ∑ over 256 symbols ∑ bits per each data RE and complementary (LD) pilot RE
      - Skip PHY Link, excluded subcarriers, continuous pilots
      - Skip probe region
    - US_Frame_Data_Load has the same value every frame
  - CLT_US_DataRate = (US_Frame_Data_Load / US_Frame_Length) (bits/sec)
    - This establishes nominal data rate for CNU PMA_UNITDATA.request() service interface => negotiated upstream PHY data rate
    - This does not include PCS or burst marker overheads, CLT will include overheads in grant allocation calculations based on CLT_US_DataRate.

CLT_US_DataRate EXAMPLE

Upstream

Subcarriers (20 MHz)	Pilot Overhead (approximate)	PHY Link Overhead subcarriers	Subcarrier for Data (approximate)	Bits per subcarrier	Bits per Symbol	US_Frame_Data_Load bits / frame
400	4.4%	8	392	10	3747	959232

Symbol Duration seconds	Cycle Prefix seconds	Extended Symbol seconds	Frame Symbols	Probe Symbols	Frame_Length seconds	Frame_Length TQs (16ns)
0.00002	0.0000005	0.0000205	256	5	0.0053505	334406.3

CLT_US_DataRate = (US_Frame_Data_Load / Frame_Length) = 179,278,945.89 (bits / second)

Observations on Example:

1. Example includes no excluded subcarriers
2. Pilot overhead and US_Frame_Data_Load is approximate. Must be based on actual pilot placement over the entire frame.
3. Example shows same bits per subcarrier loading, will be based on cable operator provisioning, band edges, etc. and impact of low density pilots (complementary pilots)
4. Vendor's calculation method will be implementation dependent. However, CNU calculation must produce the same result as CLT calculation

PROPOSED MOTION

Move to:

Adopt the PMA Service Interface text in laubach_3bn_09_0914.pdf into the next draft.

Thank you

BACKUP SLIDE

Approximate overheads as supplied by Avi Kliger:

num of symbols	pilot spacing	Overhead
8	8	4.4%
8	4	7.5%
8	2	13.8%
8	1	26.3%
16	8	2.2%
16	4	3.8%
16	2	6.9%
16	1	13.1%