802.3dj D1.0 Comment Resolution Common Topics

Matt Brown (Alphawave Semi), 802.3dj Chief Editor

Introduction

- This slide package was assembled by the 802.3dj editorial team to provide background and detailed resolutions to aid in comment resolution.
- Specifically, these slides are for the various common (not one specific track) comments.

Precoding

Precoding
Comments 21, 547, 582, 146, 145, 147, 148, 540, 541

Cl 176 SC 176 P 242 L 10 # 21

Liu, Cathy Broadcom

Comment Type T *Comment Status* X

In this section, precoding is mentioned to CR, KR and C2C links. How about C2M link? It should add C2M since C2M LT session specifies precoding as one of the options.

SuggestedRemedy

Add C2M link into the statement: "The precoding specifications in this subclause apply to the input and output lanes of a PMA that are connected to the service interface of an xBASE-CRn or xBASE-KRn PMD, or are part of an xAUI-n C2C/C2M link."

Proposed Response *Response Status* O

In addition to C2M links, all PAM4 optical PMDs require precoding as well. See next slide. Note that it is implicit that this PMA would not ever be connected to a PMD or AUI with lane signaling rates lower than 200 Gb/s, so no further clarification is required. [except 1.6TAUI-16]

Editor's recommendation:

Change the first sentence in 176.9.1.2 to the following:
"The precoding specifications in this subclause apply to the input and output lanes of a PMA that are connected to the service interface of an xBASE-KRn, xBASE-CRn, xBASE-DRn, or xBASE-FRn-500 PMD, or are part of an xAUI-n C2C or C2M link."

176.9.1.2 Precoding

The precoding specifications in this subclause apply to the input and output lanes of a PMA that are connected to the service interface of an xBASE-CRn or xBASE-KRn PMD, or are part of an xAUI-n C2C link.

The PMA shall provide 1/(1+D) mod 4 precoding capability on each transmit lane and may optionally provide 1/(1+D) mod 4 decoding capability on each receive lane. Precoding is implemented as specified in 135.5.7.2.

The precoder is enabled independently on the Tx output, Rx input, Rx output, and Tx input on each lane. Precoding is enabled and disabled using variables precoder_tx_out_enable_*i*, precoder_rx_in_enable_*i*, precoder_rx_out_enable_*i*, and precoder_tx_in_enable_*i* (where *i* is in the range 0 to 7).

If the PMA is connected to the service interface of an xBASE-CRn or xBASE-KRn PMD and training is enabled by the management variable mr_training_enable (see 136.7), then precoder_tx_out_enable_*i* and precoder_rx_in_enable_*i* shall be set as determined by the PMD control function in the LINK_READY state on lane *i* (see 136.8.11.7.5 and Figure 136–7). The method by which the PMD control function affects these variables is implementation dependent.

If the PMA is connected to the service interface of an xBASE-CRn or xBASE-KRn PMD and training is disabled by the management variable mr_training_enable, or if the PMA is part of an xAUI-n link, then precoder_tx_out_enable_*i*, precoder_rx_in_enable_*i*, precoder_rx_out_enable_*i*, and precoder_tx_in_enable_*i* are set as required by the implementation.

Precoding
Comments 21, 547, 582, 146, 145, 147, 148, 540, 541

Per motion #2 at the May Interim meeting, transmitter precoding was adopted along with OLT for all of the PMDs in Clause 180 through Clause 183.
For PMDs defined in Clause 180 and 181, the transmit precoding function is specified in Clause 176 (200G/400G/800G/1.6TBASE-R SM-PMA).
For PMDs defined in Clause 182 and 183, the transmit precoding function is specified in Clause 177 (200G/400G/800G/1.6TBASE-R Inner FEC)

Motion #2

Move to adopt OLT baseline per ghiasi_3dj_04a_2405 pages 3 and 4.

M: Ali Ghiasi
S: Matt Brown
Technical (>=75%)
802.3 voters only
Result: Y: 73 , N: 7, A: 13 Passed at 2:20 p.m.

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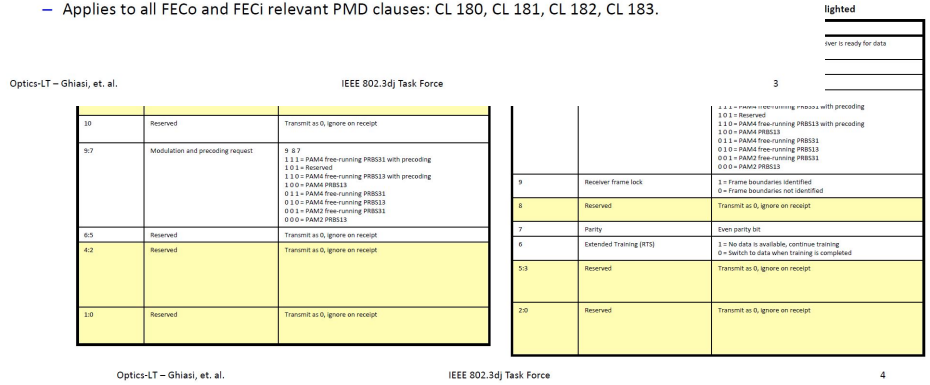
https://www.ieee802.org/3/dj/public/24_05/motions_3dj_2405.pdf

Scope of OLT Proposal

- **Baseline proposal to to use CL176A AUI link training for optical link training OLT**
- **OLT baseline provides following function:**
  - Use the same training frame as CL176A structure
  - OLT baseline is based on CL176A but with some of fields changed to reserved
  - OLT uses relevant state diagram from CL176A (one not related to coefficient update)
    - For example, we don't need coefficient update state diagram
  - Propagating RTS (Ready to Send) status from PCS-AUI-optical-AUI-PCS
  - Precoder enable/disable
    - Transmitter pre-coder is mandatory to implement but optional to enable using OLT
- **Follow Control Function of Clause 179.8.9 PMD for optical clauses implementation**
  - Applies to all FECo and FECi relevant PMD clauses: CL 180, CL 181, CL 182, CL 183.



https://www.ieee802.org/3/dj/public/24_05/ghiasi_3dj_04a_2405.pdf

Precoding
Comments 21, 547, 582, 146, 145, 147, 148, 540, 541

Cl **177** *SC* **177.4.7.2** *P* **256** *L* **13** # 582

Ghiasi, Ali — Ghiasi Quantum/Marvell

Comment Type **T** *Comment Status* **X**

Pre-coding was shown on riani_3dj_01a_2303 FECI baseline that when was adopted, and pre-coding is essential for FECi PMDs

SuggestedRemedy

Please insert text for pre-coder in this sub-clause. as specified in 135.5.7.2, 120.5.7.2, and 173.5.7.2, 6 and 176.9.1.2, that may be enabled or disabled as needed with OLT, without OLT the optical transmitter should enable 1/(1+D) mod 4 precoding to mitigate burst error. See Ghiasi/Riani May-24 presentation on the need for pre-coder

Proposed Response *Response Status* **O**

Cl **177** *SC* **177.4.7.2** *P* **256** *L* **12** # 547

Rechtman, Zvi — Nvidia

Comment Type **TR** *Comment Status* **X**

The 128,120 Hamming code is very sensitive to error propagation since it can correct up to one error in hard decoding and three errors in soft decoding. Hence, precoding is required

SuggestedRemedy

Add precoding, and use the same definition of precoding similar to 176.9.1.2.

Proposed Response *Response Status* **O**

177.4.7.1 Gray mapping

The Gray mapping for PAM4 encoded lanes is identical to that specified in 120.5.7.1.

177.4.7.2 Precoding

Editor's note (to be removed in the next draft):
Precoding was not explicitly called out in the adopted baselines. If necessary, a proposal is required. Otherwise this subclause will be removed.

Current specifications of precoding and gray mapping

120.5.7.1 Gray mapping for PAM4 encoded lanes

For output lanes encoded as PAM4 (for 200GBASE-R, where the number of output lanes is 4, or for 400GBASE-R, where the number of output lanes is 4 or 8), the PMA transmit process shall map consecutive pairs of bits {A, B}, where A is the bit arriving first, to a Gray-coded symbol as follows:

{0, 0} maps to 0,
{0, 1} maps to 1,
{1, 1} maps to 2, and
{1, 0} maps to 3.

For input lanes encoded as PAM4 (for 200GBASE-R, where the number of input lanes 4, or for 400GBASE-R, where the number of input lanes is 4 or 8), the PMA receive process shall map Gray-coded PAM4 symbols to pairs of bits {A, B} where A is considered to be the first bit as follows:

0 maps to {0, 0},
1 maps to {0, 1},
2 maps to {1, 1}, and
3 maps to {1, 0}.

135.5.7.2 Precoding for PAM4 encoded lanes

The precoding specifications in this subclause apply to the input and output lanes of a PMA that are connected to the service interface of a 50GBASE-R or 100GBASE-R PMD that includes the PMD control function defined in 136.8.11 (50GBASE-CR, 50GBASE-KR, 100GBASE-CR2, or 100GBASE-KR2), or are part of a 50GAUI-1 C2C or 100GAUI-2 C2C link.

The PMA shall provide 1/(1+D) mod 4 precoding capability on each output lane and may optionally provide 1/(1+D) mod 4 decoding capability on each input lane.

On each output lane, for each Gray-coded symbol G(j), a precoded symbol P(j) shall be determined by the following algorithm, where j is an index indicating the symbol number:

$P(j) = (G(j) - P(j\text{-}1)) \bmod 4$, when precoding is enabled (135–1)

$P(j) = G(j)$, when precoding is disabled (135–2)

On each input lane, for each precoded symbol P(j), a Gray-code symbol G(j) shall be determined by the following algorithm:

$G(j) = (P(j) + P(j\text{-}1)) \bmod 4$, when precoding is enabled (135–3)

$G(j) = P(j)$, when precoding is disabled (135–4)

The precoder is enabled independently for the input and output in each direction (Tx direction toward the PMD and Rx direction toward the MAC) and on each lane. Precoding is enabled and disabled using variables precoder_tx_out_enable_i, precoder_rx_in_enable_i, precoder_rx_out_enable_i, and precoder_tx_in_enable_i. If a Clause 45 MDIO is implemented, these variables are accessible through registers 1.600, 1.601, 1.602, and 1.603 (see 45.2.1.139 through 45.2.1.142). An example relating the variables with input and outputs is provided in Figure 135–7.

If the PMA is connected to the service interface of a PMD that includes the PMD control function and training is enabled by the management variable mr_training_enable (see 136.7), then precoder_tx_out_enable_i and precoder_rx_in_enable_i shall be set as determined by the PMD control function in the LINK_READY state on lane i (see 136.8.11.7.5 and Figure 136–7). The method by which the PMD control function affects these variables is implementation dependent.

If the PMA is connected to the service interface of a PMD that supports the PMD control function and training is disabled by the management variable mr_training_enable, or if the PMA is part of a 50GAUI-1 C2C or a 100GAUI-2 C2C link, then precoder_tx_out_enable_i, precoder_rx_in_enable_i, precoder_tx_in_enable_i, and precoder_rx_out_enable_i are set as required by the implementation. The method described in 135F.3.2.1 may be used for 50GAUI-1 C2C or 100GAUI-2 C2C.

Note that precoding and inverse precoding are not explicitly labelled. Rather they are defined as processes for input lanes and output lanes, respectively. Similar for Gray mapping and inverse Gray mapping.

When referencing these subclauses, we need to be careful with the language we choose.

Precoding
Comments 21, 547, 582, 146, 145, 147, 148, 540, 541

Editor's recommendation for 177.4.7

Replace 177.4.7 including the editor's note in 177.4.7.2 with the following:

177.4.7 PAM4 encoding
The PAM4 encoding function includes Gray mapping as specified in 177.4.7.1 and precoding as specified in 177.4.7.2.

177.4.7.1 Gray mapping
The Gray mapping for PAM4 encoded lanes is implemented as specified for output lanes in 120.5.7.1.

177.4.7.2 Precoding
The Inner FEC shall provide 1/(1+D) mod 4 precoding capability on each transmit lane.
Precoding is implemented as specified for output lanes in 135.5.7.2.
Tx precoding is enabled and disabled using variables precoder_tx_out_enable_i (where i is in the range 0 to 7).
If training is enabled by the management variable mr_training_enable (see 176A.11), then precoder_tx_out_enable_i shall be set as determined by the inter-sublayer link training function in the LINK_READY state on lane i (see Figure 176A-6). The method by which the inter-sublayer link training function affects this variable is implementation dependent.
If training is disabled by the management variable mr_training_enable precoder_tx_out_enable_i is set as required by the implementation (see 177.5.1).

Precoding
Comments 21, 547, 582, 146, 145, 147, 148, 540, 541

Editor's recommendation for 177.5…

Create new subclause prior to current 177.5.1 as follows:

177.5.1 PAM4 decoding

The PAM4 decoding function include inverse 1/(1+D) mod 4 precoding as specified in 177.5.1.1 and inverse gray mapping as specified in 177.5.1.2. Although the PAM4 decoding function is depicted as a discrete, serial function in Figure 177-2, it may be implemented anywhere in the receive function providing the net behaviour is the same.

177.5.1.1 Inverse precoding

The Inner FEC may optionally provide inverse 1/(1+D) mod 4 precoding capability on each receive lane.
If inverse precoding is implemented, it is enabled or disabled as determined by the implementation.
If inverse precoding is enabled, the Inner FEC receive function processes the detected data equivalent to the process specified for input lanes in 135.5.7.2.
If inter-sublayer link training function is enabled by the management variable mr_training_enable (see 176A.11), the precoding state on the link partner transmitter is requested using the inter-sublayer link training function.
If inter-sublayer link training function is disabled by the management variable mr_training_enable, the precoding state on the link partner transmitter is set by management.

177.5.1.2 Inverse Gray mapping

The inverse Gray mapping for PAM4 encoded lanes is identical to the process specified for input lanes in 120.5.7.1.

Precoding
Comments 21, 547, 582, 146, 145, 147, 148

Cl **181** SC **181.4** P**373** L**33** # 145

Ghiasi, Ali — Ghiasi Quantum/Marvell

Comment Type **T** *Comment Status* **X**

Prior to 181.4 add section for PMA function to support precoder to mitigate burst errors

SuggestedRemedy

The transmitter need to supports 1/(1+D) mod 4 precoding, as specified in 135.5.7.2, 120.5.7.2, and 173.5.7.2, 6 and 176.9.1.2, that may be enabled or disabled as needed with OLT, without OLT the optical transmitter should enable 1/(1+D) mod 4 precoding to mitigate burst error.

Proposed Response *Response Status* **O**

Cl **180** SC **180.4** P**349** L**10** # 146

Ghiasi, Ali — Ghiasi Quantum/Marvell

Comment Type **T** *Comment Status* **X**

Prior to 180.4 add section for PMA function to support precoder to mitigate burst errors

SuggestedRemedy

The transmitter need to supports 1/(1+D) mod 4 precoding, as specified in 135.5.7.2, 120.5.7.2, and 173.5.7.2, 6 and 176.9.1.2, that may be enabled or disabled as needed with OLT, without OLT the optical transmitter should enable 1/(1+D) mod 4 precoding to mitigate burst error.

Proposed Response *Response Status* **O**

Cl **182** SC **182.4** P**397** L**20** # 147

Ghiasi, Ali — Ghiasi Quantum/Marvell

Comment Type **T** *Comment Status* **X**

Prior to 182.4 add section for PMA function to support precoder to mitigate burst errors

SuggestedRemedy

The transmitter need to supports 1/(1+D) mod 4 precoding, as specified in 135.5.7.2, 120.5.7.2, and 173.5.7.2, 6 and 176.9.1.2, that may be enabled or disabled as needed with OLT, without OLT the optical transmitter should enable 1/(1+D) mod 4 precoding to mitigate burst error.

Proposed Response *Response Status* **O**

Cl **183** SC **183.4** P**420** L**37** # 148

Ghiasi, Ali — Ghiasi Quantum/Marvell

Comment Type **T** *Comment Status* **X**

Prior to 183.4 add section for PMA function to support precoder to mitigate burst errors

SuggestedRemedy

The transmitter need to supports 1/(1+D) mod 4 precoding, as specified in 135.5.7.2, 120.5.7.2, and 173.5.7.2, 6 and 176.9.1.2, that may be enabled or disabled as needed with OLT, without OLT the optical transmitter should enable 1/(1+D) mod 4 precoding to mitigate burst error.

Proposed Response *Response Status* **O**

These comments are resolved using the response provided on the previous page.