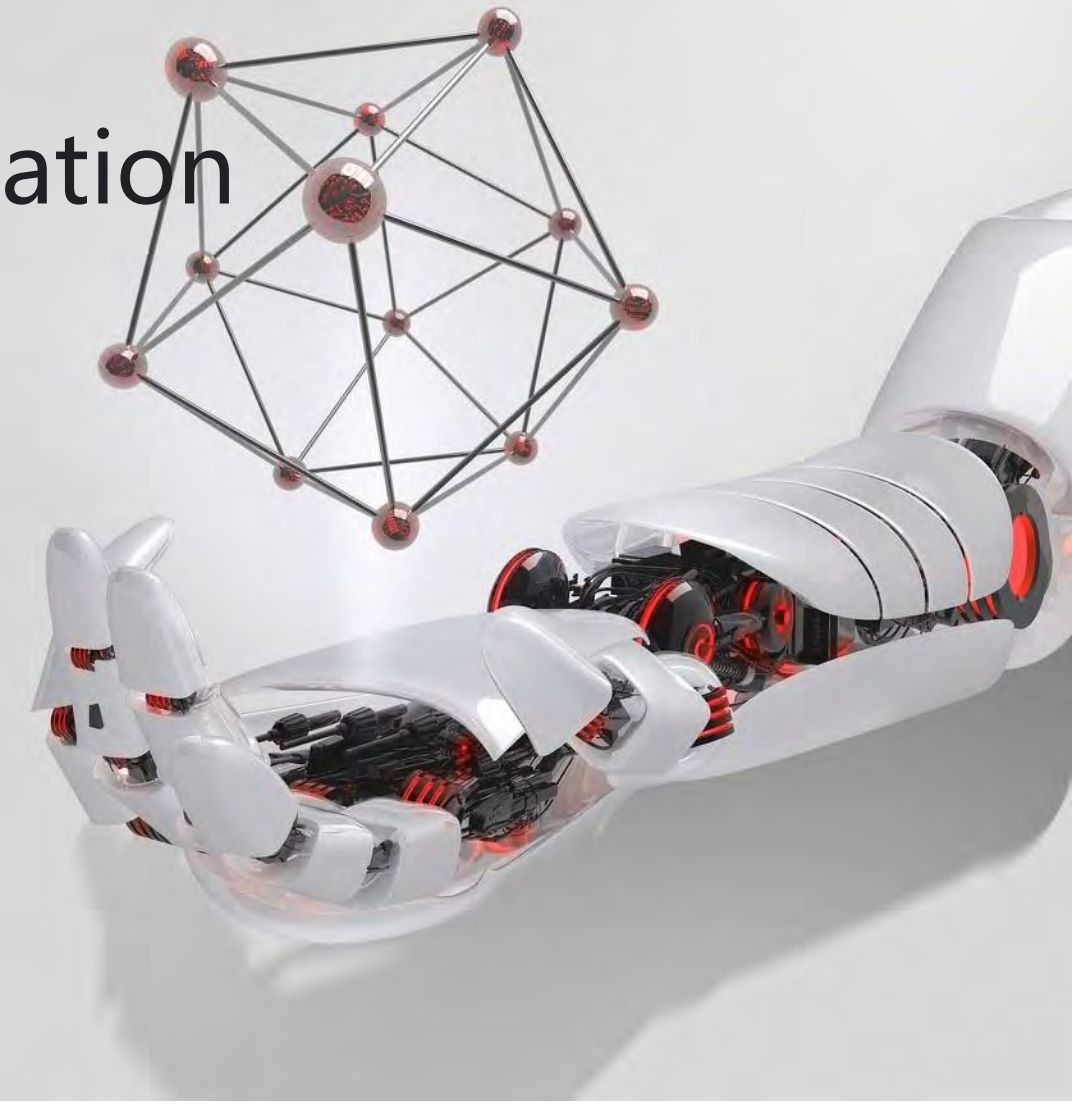
Proposal to update the specification of 2km optical PMDs



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Introduction

- The 802.3dj task force has recently released the updated D1.1 specification of 2km optical PMDs.
- Some refinement has been done over the last round of comment resolutions.
- There are still some fundamental TBDs left in the baselines, which largely points to the unsettlement of Ref. Rx
  - CD specs
  - TECQ/TDECQ max
  - CD penalty |TDECQ-TECQ|
  - Stressed Rx. Sens.

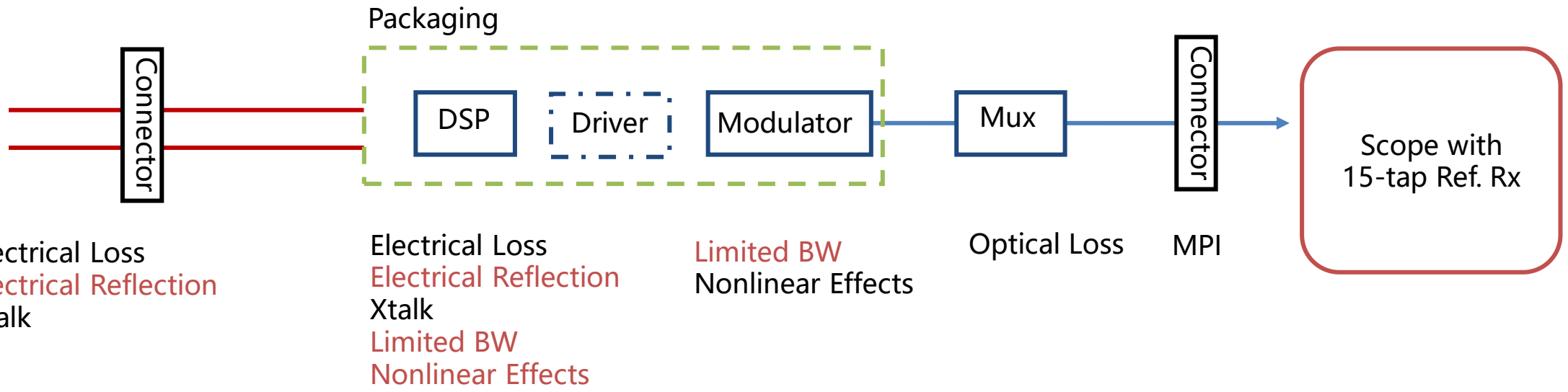
← **Looks like moving towards consensus**

Relies on
1. **definition of Ref. Rx, i.e. tap limits of the 15-tap FFE**
2. **definition of BER threshold used in TECQ**

- This presentation provides suggestions to further improve the specification.

Tap Limits of the 15-tap FFE

Consider a typical Transmitter system ,



- The industry likely will design one set of implementation to work in either FECi or FECo modes, depending on the tested performance of each individual part and its part code
- For the same transmitter system, the impairment needing equalization is set.

113.4375GBd ←→ 106.25GBd

stronger EQ. Weaker EQ.

How significant will the difference be?

A 3-tap FFE analogy: analytical analysis

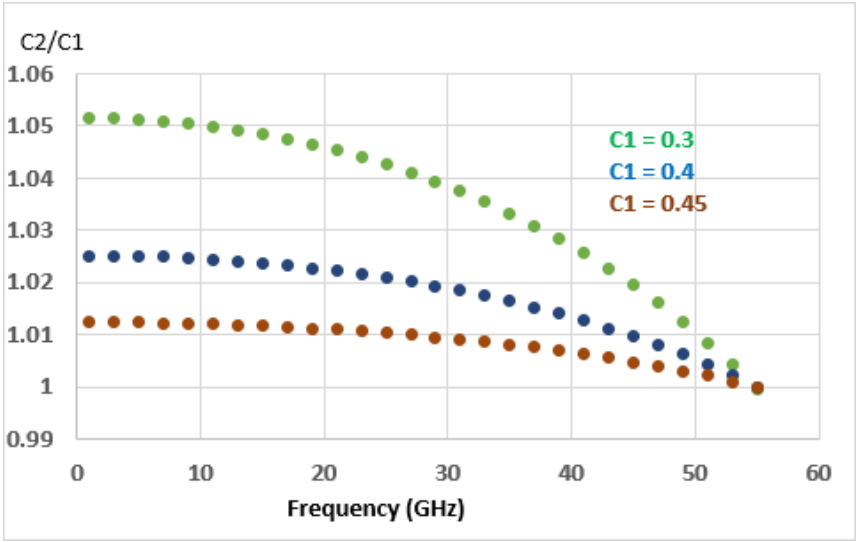
- Assume tap weights [-c1,c0,-c1] @ f_1 =>106.25GB and [-c2,c0,-c2] @ f_2 =>113.4375GB.
- For the transmitter to get stronger equalization @ 113.4375GB, the amplitude of the equalizer's frequency response should be higher than that for 106.25GB , the relation between c1 and c2 is as following:

To satisfy $H\left(\frac{2\pi f}{f_1}\right) \geq H\left(\frac{2\pi f}{f_2}\right)$

We need:

$$c2 \geq \frac{\left(1-cos\left(\frac{2\pi f}{f_1}\right)\right) * c1}{1-cos\left(\frac{2\pi f}{f_2}\right)+2*c1*\left(cos\left(\frac{2\pi f}{f_2}\right)-cos\left(\frac{2\pi f}{f_1}\right)\right)},$$

where $f_2 > f_1$, $0 < f \leq \frac{f_1}{2}$



Observations

1. The ratio of c2/c1 varies monotonically with frequency, with its maximum value occurs at f=0:

$$c2_{max} = (c1 * f2/f_1)/(\frac{f_1}{f_2} - 2 * c1 * \left(\frac{f_1}{f_2} - \frac{f_2}{f_1}\right) \qquad for\ f = 0$$

2. The ratio of c2/c1 decreases with higher value of c1. For a tap limit>0.4, the difference is a minimal value of 0.01

Using one set of tap limit for the 15-tap FFE

The case of 15-tap FFE will be more complicated.
Defining a tap limit to avoid excessive equalization, with margins incorporated

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stronger EQ. Weaker EQ.

Tap limit ⊇ Tap limit

Dependent on the same implementation
i.e., same impairment

Apply one set of tap limit

Build an envelope
One single mode in scope

	Symbol	Min	Max	Units
Feedforward equalizer (FFE) length	N_b		15	UI
Maximum FFE pre-cursors			3	UI
Maximum FFE post-cursors			13	UI
FFE main tap coefficient limit		0.9	2.5	-
Normalized FFE coefficient limits† *n* = -3 *n* = -2 *n* = -1 *n* = 1 *n* = 2 *n* ≥ 3	bb(n)	 -0.1 -0.1 TBD -0.1 -0.1	 0.1 0.2 0.05 0.05 0.2 0.1	-
FFE Gain‡		1	1	-

† Measured relative to the main tap
‡ The sum of FFE Coefficients must equal one

The other knob on defining the Transmitter Metric

- Change the SER threshold used in TECQ of 2km PMDs to 9.7e-3
  - Align to the input from Logical Track's work
  - Aligning the BER requirement among FECi optical PMDs
    - DRn-2, FR4 and LR4
  - Provide consistency of the standard and avoid future confusion
    - In past generations, all PMDs using KP4 FEC shared the same BER threshold. All PAM4 PMDs used one solitary BER threshold for Rx Sens. and TECQ/TDECQ calculation. The meaning of the BER threshold has been self-explanatory.
    - For 200G/L, two FEC modes are defined, with different coding gain. Therefore it is intuitive that they have separate raw BER thresholds.
    - However, within the PMDs using FECi, the adoption of two different BER threshold has no technical basis.
    - It would cause confusion for readers of the 802.3dj standard. Let's make it precise while writing it
      - E.g. the discussion on MPI and DGD penalty in the last round of comment resolution
      - The relation between OMA and ER in 802.3df
  - Mitigation to the requirement of Tx performance can be done via setting appropriate TECQ/TDECQ max value

Summary and Proposal

- We propose the following change to the current specification of the 2km optical PMDs, including 800GBASE-DR4-2, 1600GBASE-DR4-2, 800GBASE-FR4.
  - Adopt the same tap weight limit of the 15tap reference receiver for both FECi and FECo PMDs
  - Change the SER threshold of 2km PMDs from 4e-3 to 9.7e-3