

100GBASE-KR1/CR1 FEC Thoughts

IEEE P802.3ck

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Supporters

- Mike Dudek – Marvell
- Howard Heck – Intel
- Gary Nicholl – Cisco
- Shawn Nicholl - Xilinx
- Dave Ofelt – Juniper
- Rob Stone - Broadcom

Introduction

➤ We have several ways forward for the FEC strategy for 100GBASE-CR1/KR1

1. Clause 91 FEC
2. Interleaved FEC (nicholl_3ck_01a_0519)
3. Dual FEC strategy (gustlin_3ck_01_0719)

➤ July 2019 straw poll #7 straw poll showed:

For the 100GBASE-KR1/CR1 PHYs, I would support the following FEC mechanism (choose one):

- A: Single FEC, non-interleaved (clause 91)
- B: Single FEC, interleaved (nicholl_3ck_01a_0519)
- C: Dual FEC, gustlin_3ck_01_0719
- D; need more information
- A:7 B: 1 C: 25 D: 14

➤ I feel strongly that we should adopt a baseline at this meeting

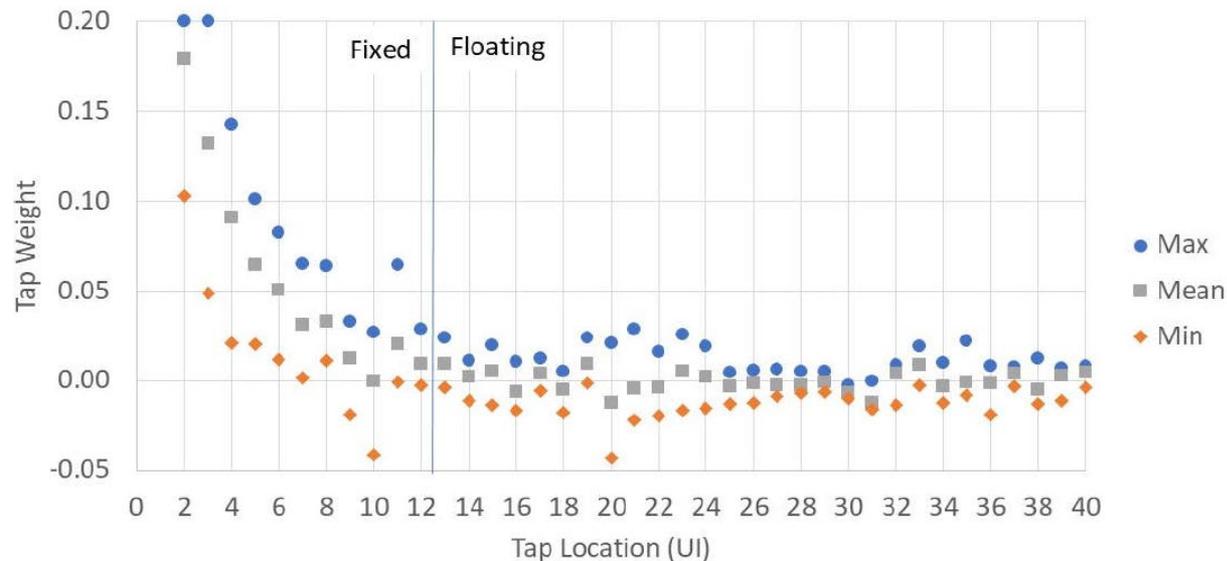
– This will help the industry prepare for 100G per lane designs

DFE Tap Data

- Howard Heck was kind enough to present data to the interested party of FECers showing tap weights that are arrived at for the various channels

Tap Weights for $b_{\max}(2..n)=0.2$

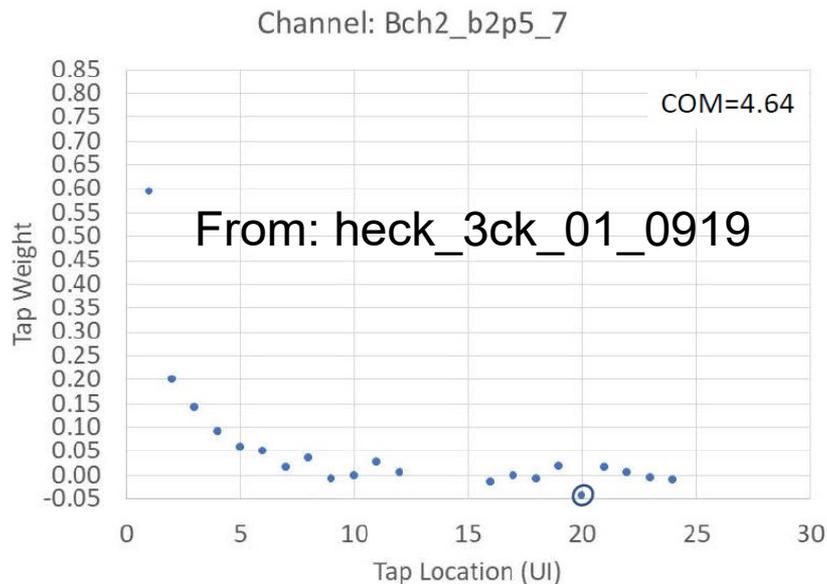
Note: 1st postcursor tap is not shown.



From: heck_3ck_01_0919

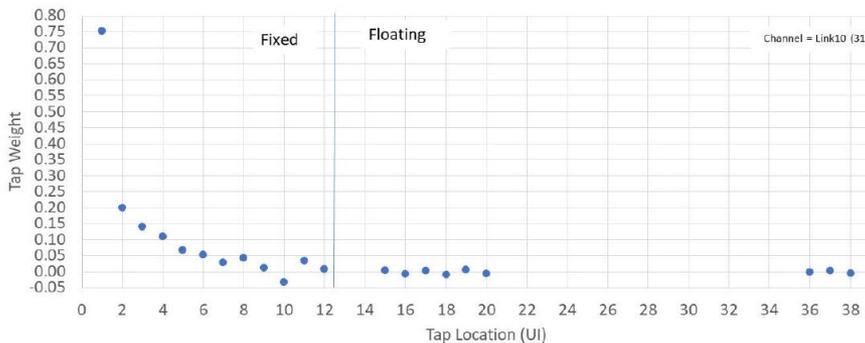
DFE Tap Data and Simulation

➤ A few of the channels that have negative tap weights

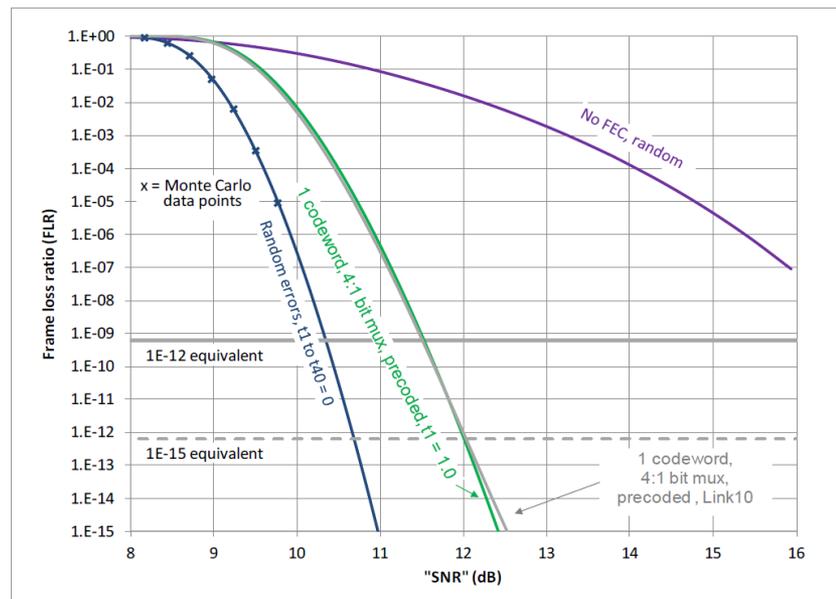


Tap Weights: Link10 with 12mm package

This is one of the channels that has 9 changes in the sign of the tap weight.



100G with 40-tap DFE Link10 with precoding



From: anslow_3ck_01_xxx (unpublished)

Adopted DFE TAP limits

- The task force did adopt tap weight limits in the last meeting:
 - the July 2019 motion #4 adopted the values on the table with the exception that $B_{maxg} = 0.05$
 - 0.85 for the 1st tap and 0.2 for all other taps
 - This is for 100GBASE-KR1 (not CR1)
 - **No limits set for CR1 so far...**

COM Reference Rx DFE # taps, #float, span

- DFE COM parameters go into COM Table (refer to Table 137-6 for an example)

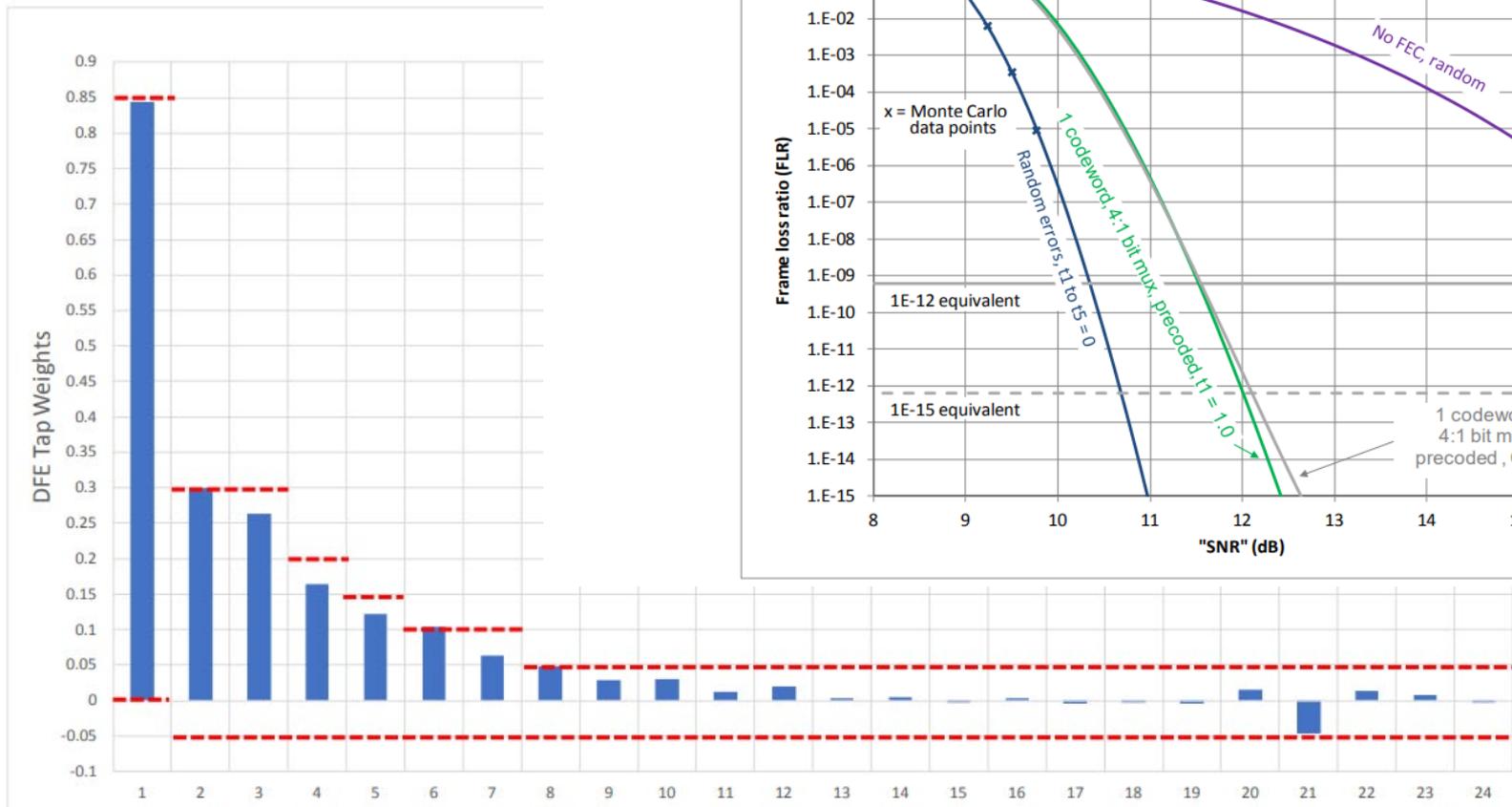
Parameter	Symbol	Value	Units
.....			
Decision feedback equalizer (DFE) length	Nb	12	UI
Normalized DFE coefficient magnitude limit n = 1		0.85	—
n = 2 to Nb		0.2	
Number of DFE floating tap groups	N_bg	3	
Number of DFE floating taps per group	N_bf	3	
UI span for floating taps	N_f	40	UI
Max DFE value for floating taps	Bmaxg	0.2	

FEC Simulations Review

➤ Good FEC performance with Clause 91 FEC

100G with 24-tap DFE CH78 with precoding

CH78

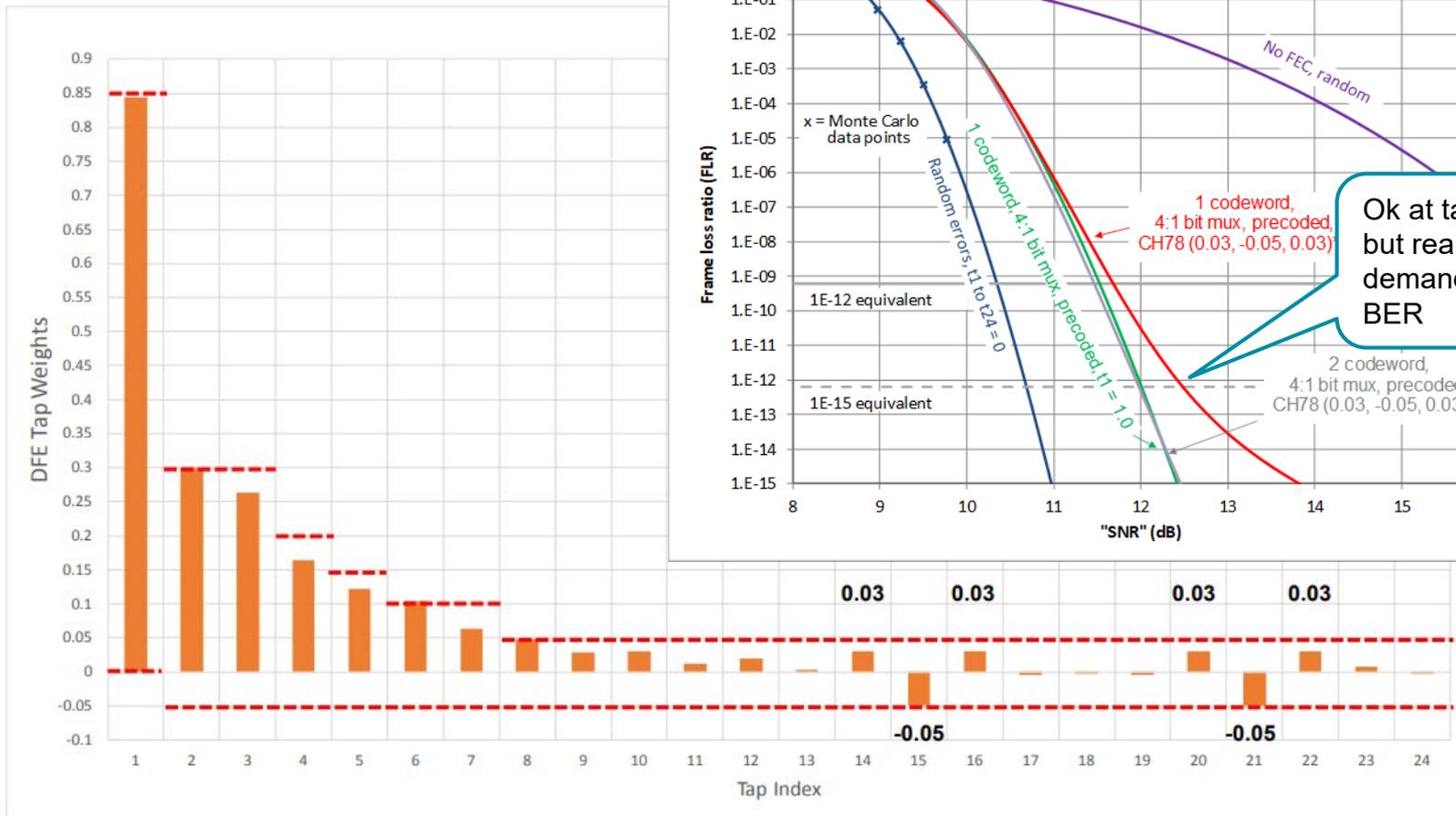


From: anslow_3ck_adhoc_01_041019.pdf

FEC Simulations Review

- Poor FEC performance with Clause 91 FEC
- But no evidence that a real channel would require tap weights like this

CH78 with modified late taps



Other Options

- RS Symbol muxing as first shown in `gustlin_3ck_01_0718.pdf` does not significantly improve on simpler bit multiplexing to matter
 - Something similar is called symbol mapping in `lu_3ck_02_0319.pdf`
- Precoding 2.0 or EoBD was shown in `lu_3ck_02_0319.pdf`
 - This is shown to improve performance in `anslow_3ck_adhoc_01_041019.pdf`
 - Feasibility or applicability is receiver architecture dependent

Thoughts

- As many have pointed out, the channels we have today for KR1, with our adopted reference receiver, don't have issues with Clause 91 FEC performance
- Pete has shown that small changes in tap weights, even in relatively late taps, can make a significant difference, even though they are well within the currently adopted tap limits, for currently contributed channels
 - Tap limits are not a complete solution
- A number of people have discussed at the microphone (but no presentations) of other mysterious burst error phenomenon, other than DFE based errors
 - Things like power supply noise etc...hard to quantify these without contributions or to know how much interleaved FEC would help or not

Conclusion

- There is concern that we will struggle with future channels, receiver architectures and deployment scenarios that we are not representing today
 - CR1 which has not been as well analyzed as KR1
 - C2C + CR1 has not been analyzed
- People have commented that:
 - Burst errors are mostly a receiver issue, and there are tools to help solve these problems
- That said, I believe we should make a decision now, and adopt clause 91 as the FEC for CR1/KR1
 - Simplest for the project, the industry and designers
 - Continue to investigate channels and tap weight limits, as well as provide other language in the standard that ensures a robust solution

Thanks!