

RS(544,514) FEC performance for KR/CR 100G and 400G

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Introduction

[wu_3ck_adhoc_01_022719](#) proposed to set:

“ $b_{\max}(1) = 0.85$ & $b_{\max}(2..N_b) = 0.35$ ”

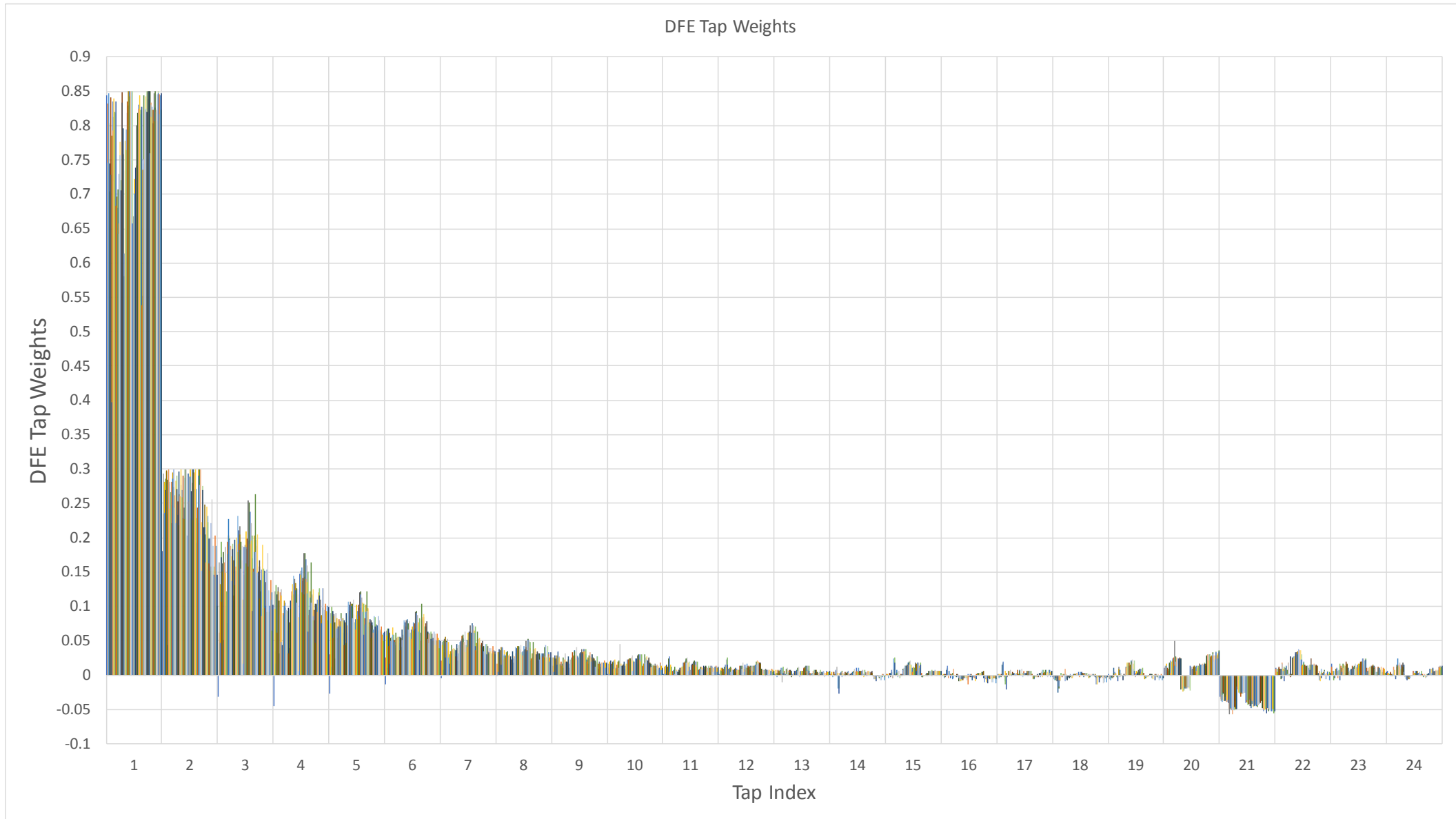
and asked whether this would cause issues with error propagation.

[sun_3ck_02a_0119.zip](#) contained a spreadsheet that included tap settings for 115 channels with the limits of:

$b_{\max}(1) = 0.85$ and $b_{\max}(2..N_b) = 0.3$

This contribution uses the data in [sun_3ck_02a_0119.zip](#) to provide the basis for some limiting tap values that might be applied.

Tap settings from [sun_3ck_02a_0119.zip](#)



Tap value max and min

Within this data set the maximum and minimum tap values observed were:

Tap	1	2	3	4	5
Max	0.85	0.3	0.264	0.178	0.123
Min	0.398	0.044	-0.032	-0.045	-0.027

Candidate DFE tap limits 1

A set of DFE tap constraints that would not exclude these tap settings (for the first 5 taps) is:

$$\begin{aligned}0 &\leq t_1 \leq 0.85 \\-0.05 &\leq t_2 \leq 0.3 \\-0.05 &\leq t_3 \leq 0.25 \\-0.05 &\leq t_4 \leq 0.2 \\-0.05 &\leq t_5 \leq 0.15\end{aligned}$$

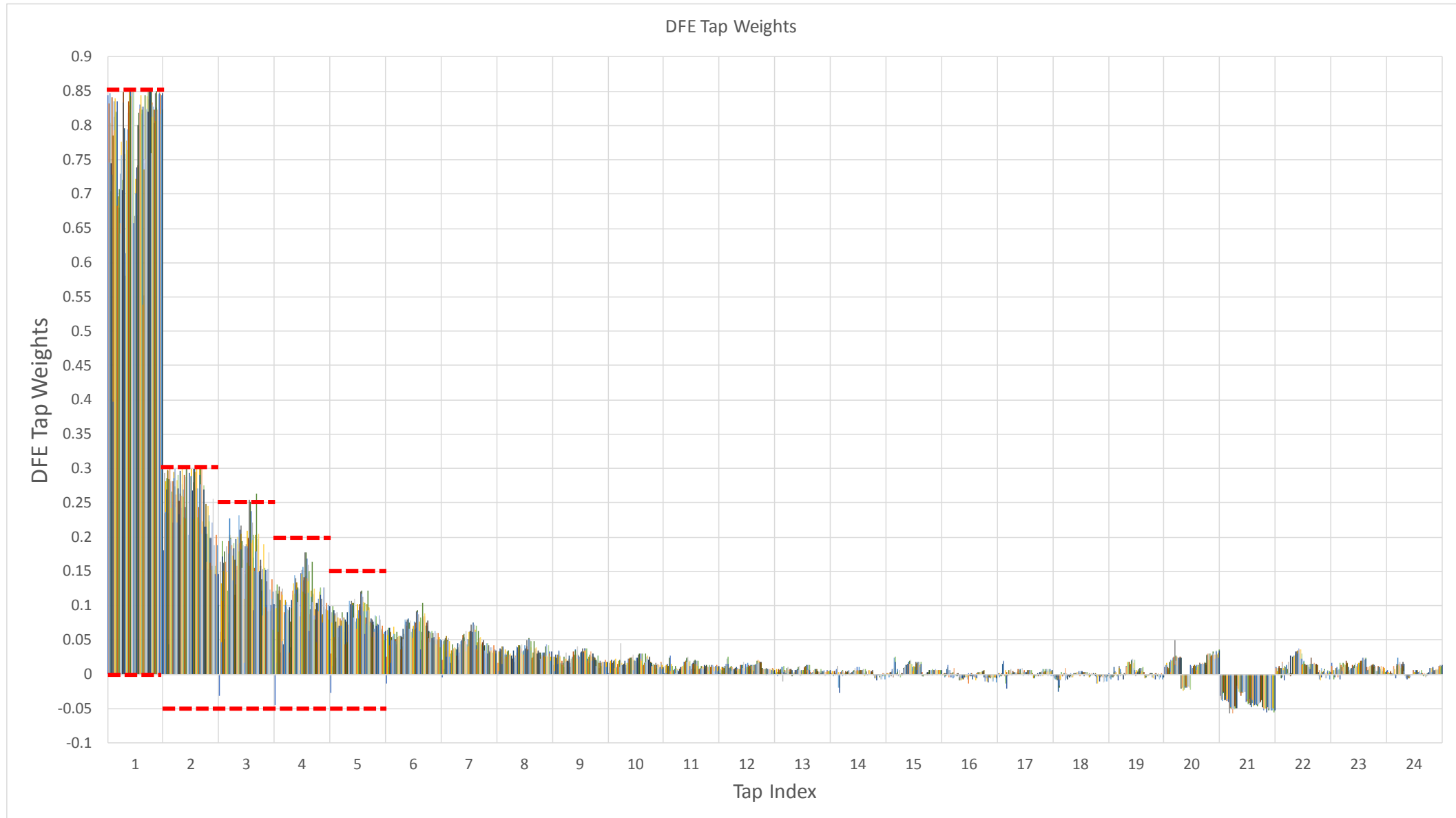
These constraints are illustrated on page 6.

To try to assess the **worst** case burst error performance within this set of tap constraints (and without going too far away from the max and min observed values on page 4), simulations were performed with tap settings:

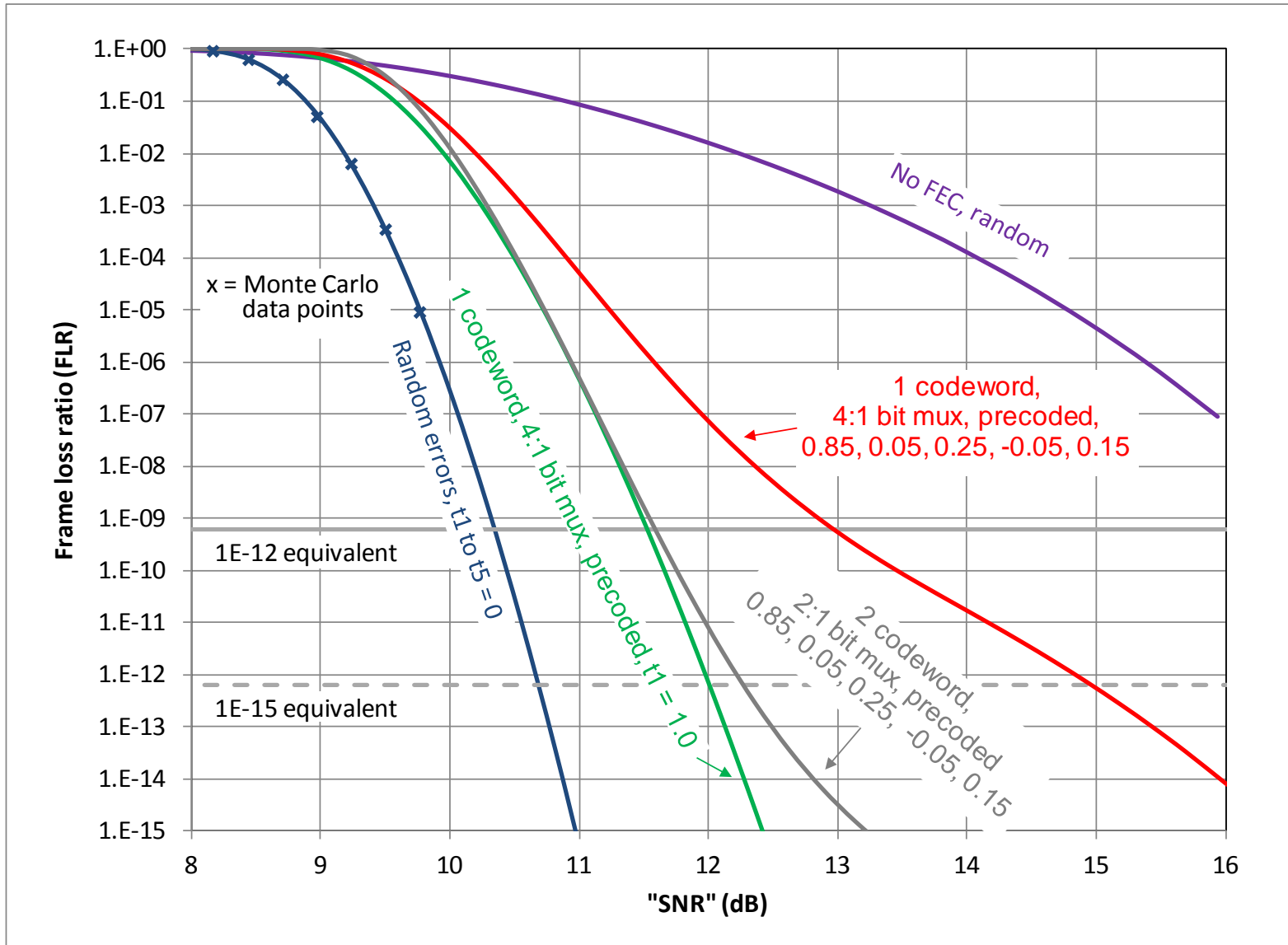
0.85, 0.05, 0.25, -0.05, 0.15

See page 7.

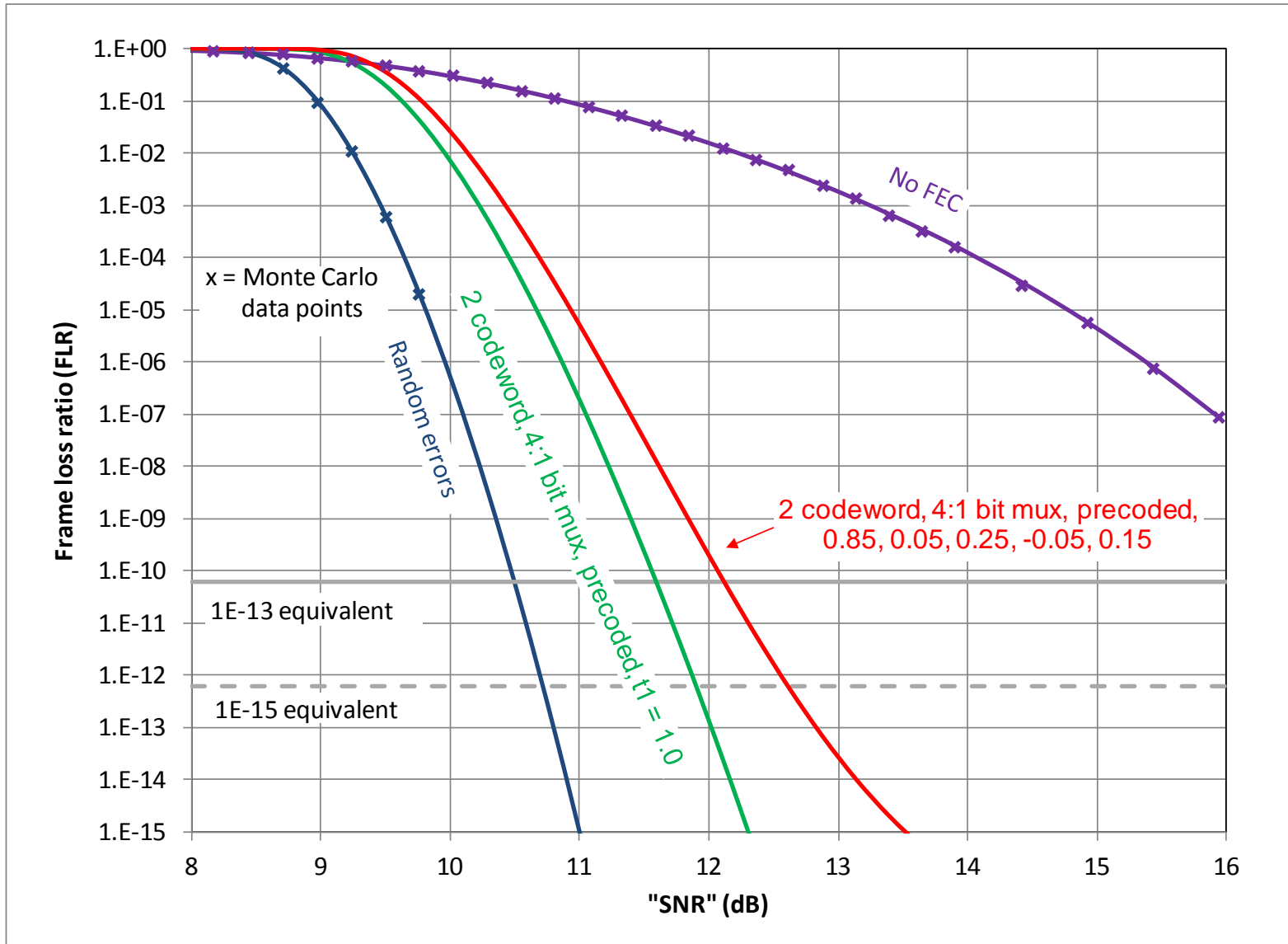
Illustration of candidate tap limits 1



100G with 5-tap DFE (0.85, 0.05, 0.25, -0.05, 0.15) with precoding



400G with 5-tap DFE (0.85, 0.05, 0.25, -0.05, 0.15) with precoding



Discussion

For the set of DFE tap constraints:

$$\begin{aligned}0 &\leq t_1 \leq 0.85 \\-0.05 &\leq t_2 \leq 0.3 \\-0.05 &\leq t_3 \leq 0.25 \\-0.05 &\leq t_4 \leq 0.2 \\-0.05 &\leq t_5 \leq 0.15\end{aligned}$$

The allowed tap settings: 0.85, 0.05, 0.25, -0.05, 0.15 give performance that is 3 dB worse than for a single tap DFE with 100G non-interleaved FEC and precoding at 1E-15 equivalent BER (see page 7).

While none of the 115 channels in [sun_3ck_02a_0119.zip](#) required tap settings that were this unfavourable for error propagation, without some additional constraint on the tap settings, how can we be sure that some channels won't be this bad?

Conclusion

Applying DFE tap constraints:

$$\begin{aligned}0 &\leq t_1 \leq 0.85 \\-0.05 &\leq t_2 \leq 0.3 \\-0.05 &\leq t_3 \leq 0.25 \\-0.05 &\leq t_4 \leq 0.2 \\-0.05 &\leq t_5 \leq 0.15\end{aligned}$$

is not sufficient to ensure acceptable performance with 100G non-interleaved FEC and precoding.

The options seem to be:

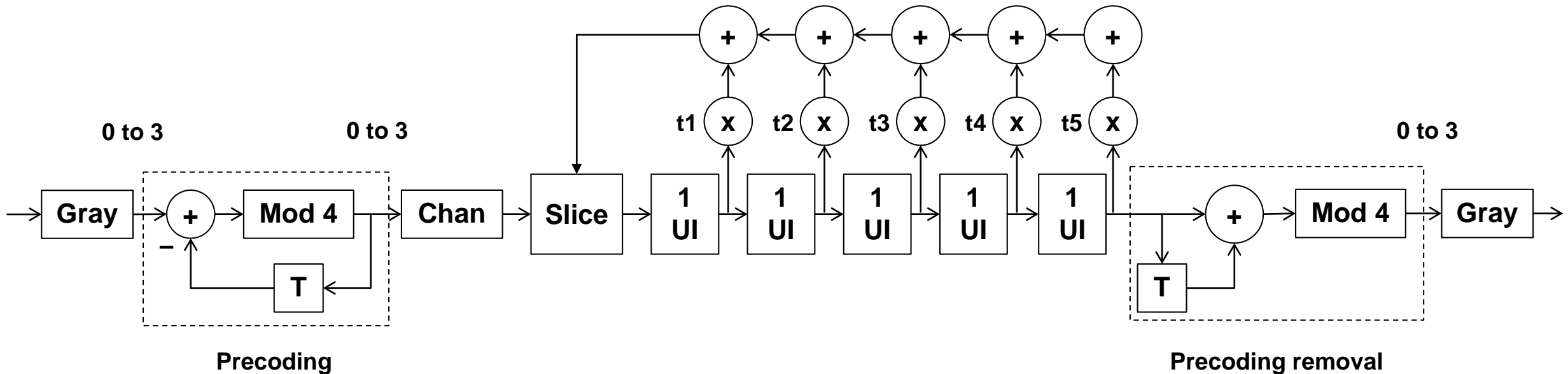
1. Adopt interleaved FEC for 100G
2. Apply additional constraints to the tap settings to restrict error propagation (seems to be feasible)
3. Accept that some compliant channels / receivers may fail to meet the target FLR

Annex

Precoding and 5-tap DFE model

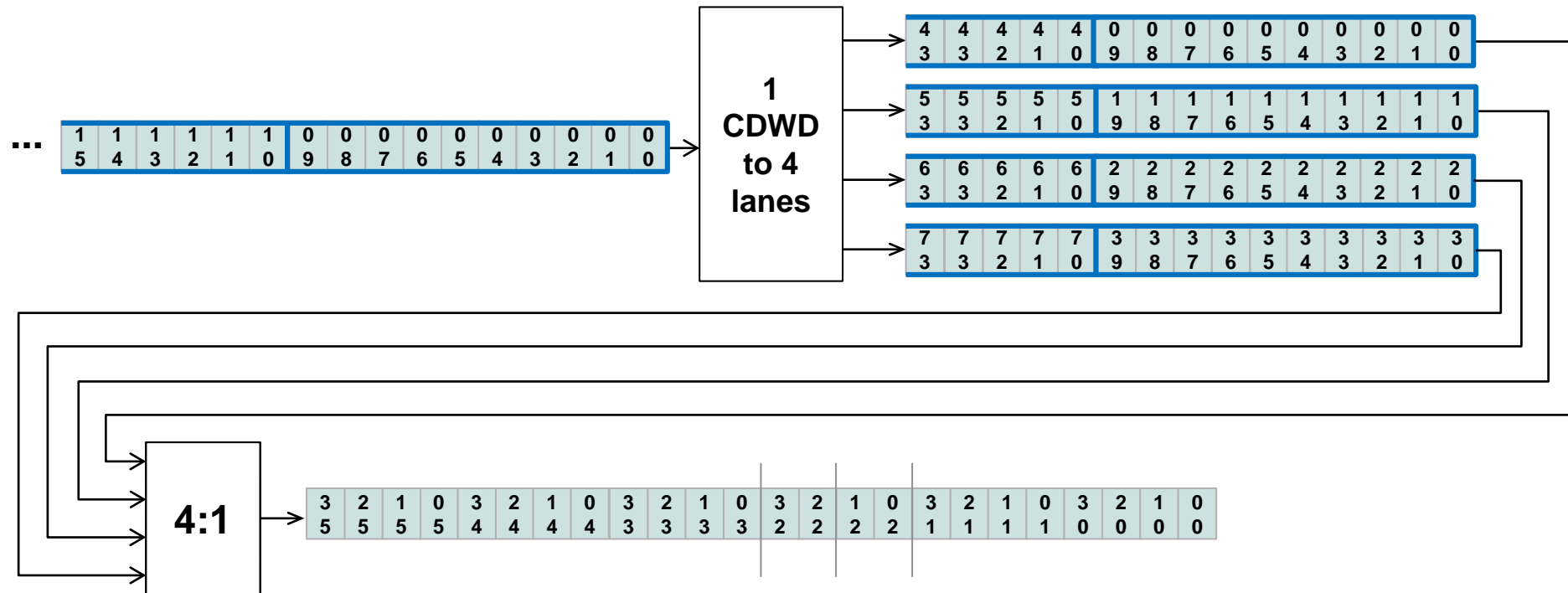
The results with precoding in [anslow_3ck_adhoc_01_072518](#) were for a 1 tap DFE where it is expected that precoding will have the effect of converting an error burst of any length into just two PAM4 symbol errors.

To try to help answer the question of what the performance will be for a realistic multi-tap DFE with precoding, the Monte Carlo model used for previous presentations was extended to include a 5-tap DFE as below.



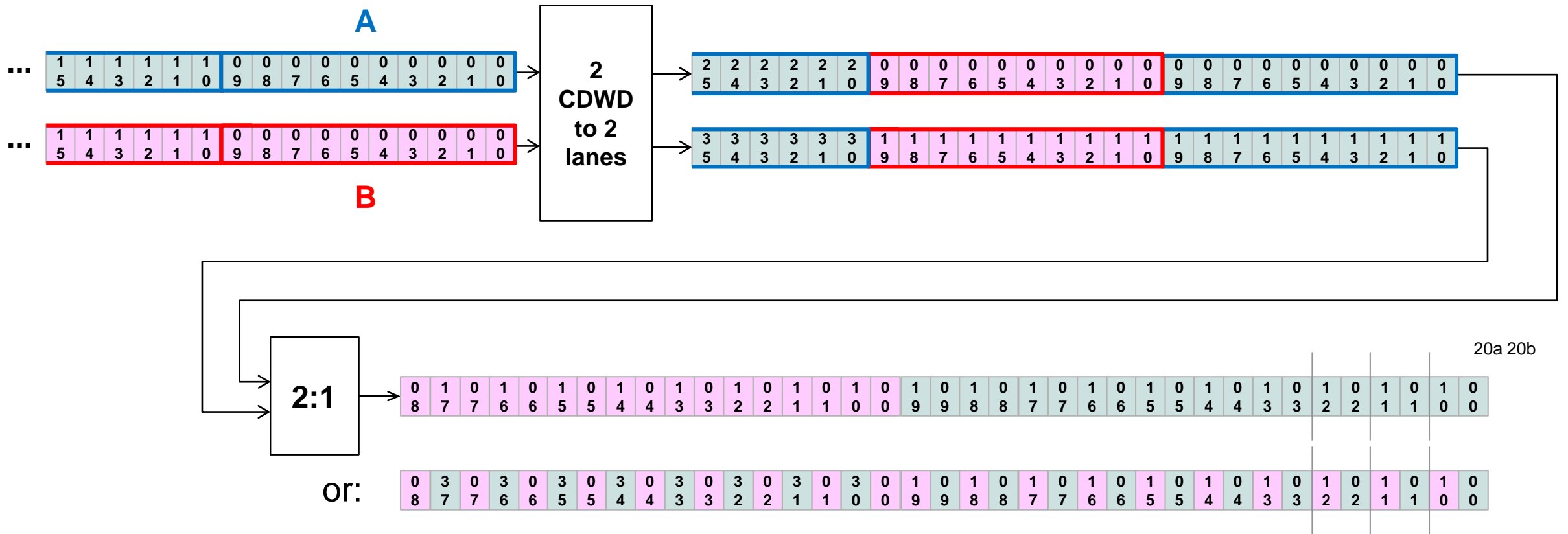
Clause 91 100G with bit mux PMA

Round robin distribution of FEC symbols to the FEC lanes. Bit multiplex in the PMA.



100G symbol interleaved to 2 lanes with bit mux PMA

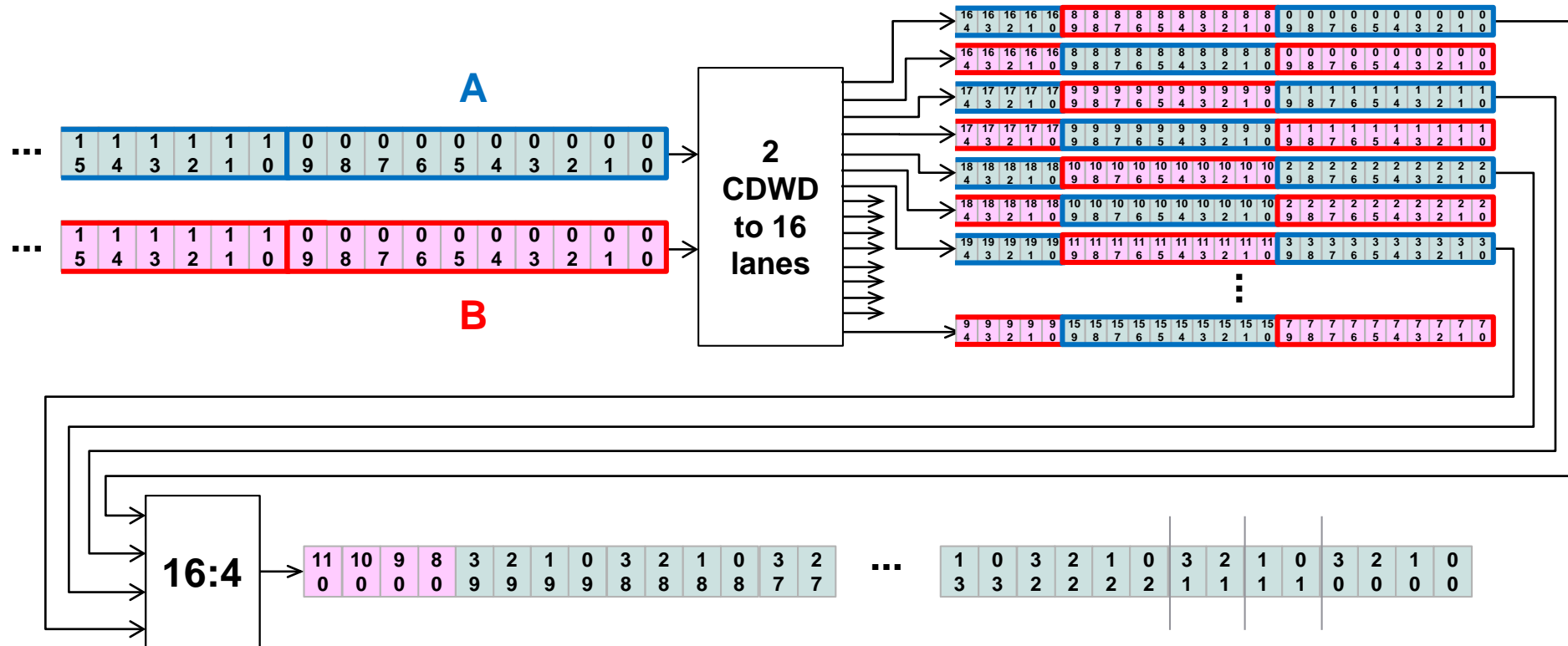
Symbol interleave from 2 FEC codewords. Bit multiplex in the PMA.



If one codeword is uncorrectable, the other is marked bad also.

Clause 119 400G with bit mux PMA

Symbol interleave from 2 FEC codewords. Bit multiplex in the PMA.



If one codeword is uncorrectable, the other is marked bad also.

Thanks!