RS(544,514) FEC performance for 100G

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Introduction

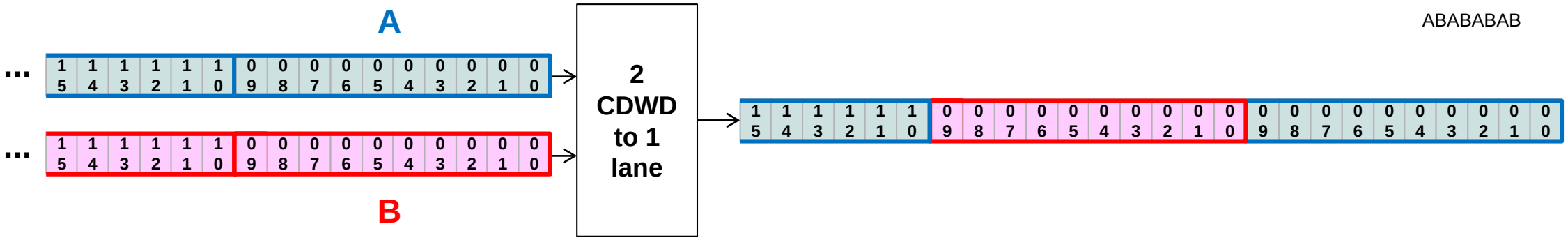
anslow_3ck_01_0918 showed that for 100G using a Clause 91 FEC sublayer, 4:1 bit muxing and precoding, the performance expected with a multi-tap DFE is likely to be unacceptable.

gustlin_3ck_adhoc_01a_100318 proposed that this issue could be fixed by interleaving two FEC codewords to form the 100G lane and included a performance curve for this case. This presentation also raised the question of whether there is a need to support a two-lane version of this interface and what the burst performance of that would be.

This presentation repeats the curve for the symbol interleaved version of the two codeword solution and then analyses a possible two-lane version.

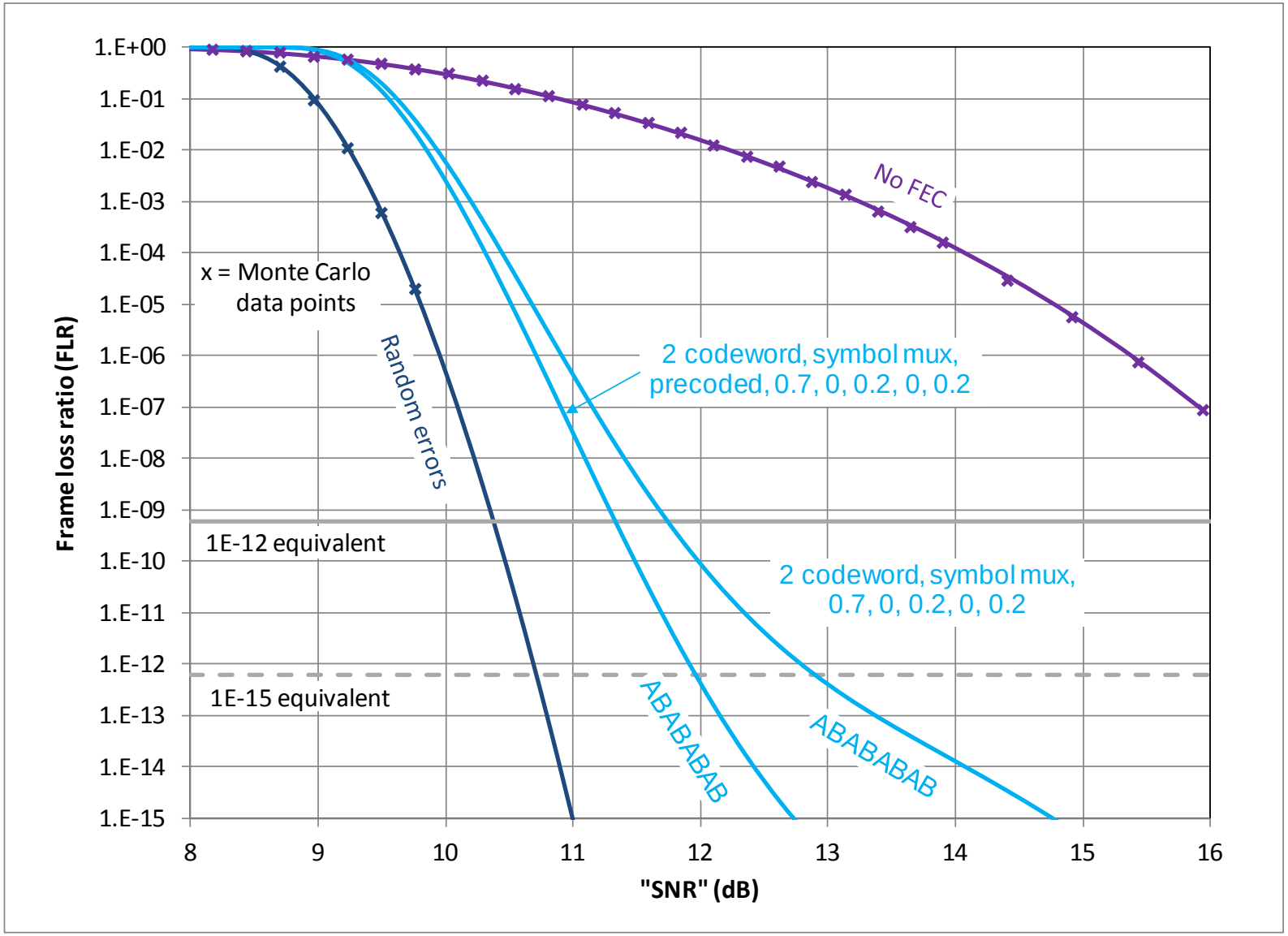
100G symbol interleaved to 1 lane

Symbol interleave from 2 FEC codewords to a single 100G lane.



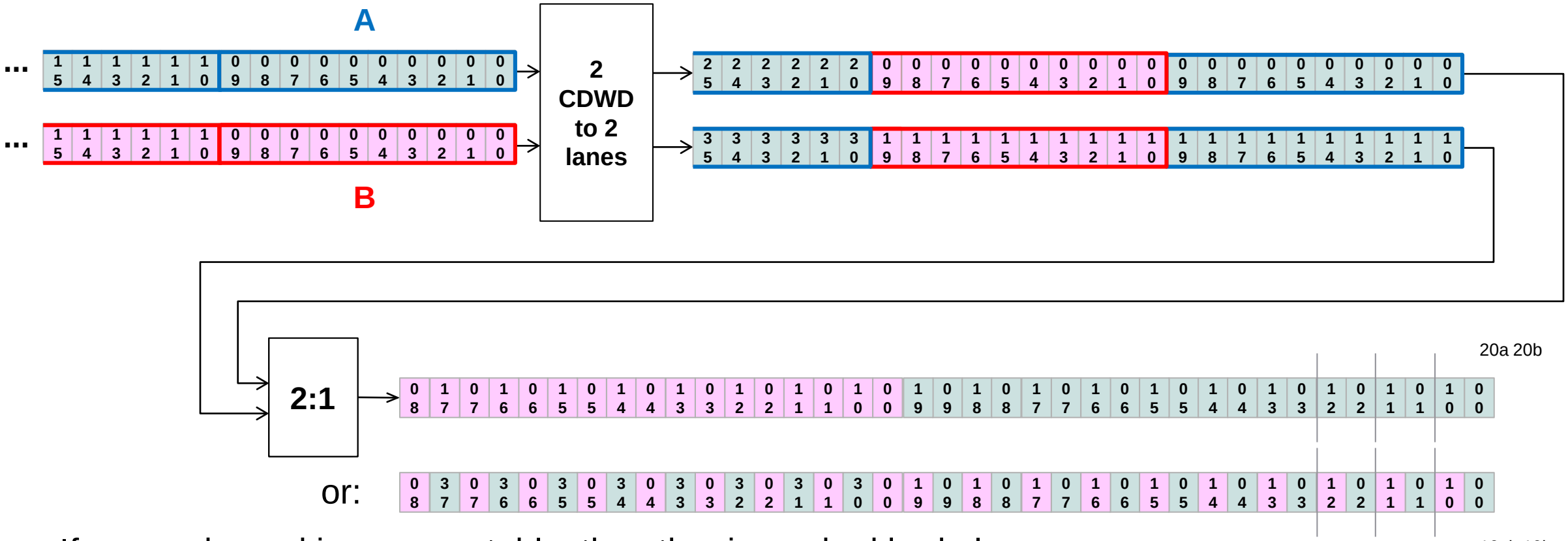
If one codeword is uncorrectable, the other is marked bad also.

100G 1 lane with 5-tap DFE (0.7, 0, 0.2, 0, 0.2)



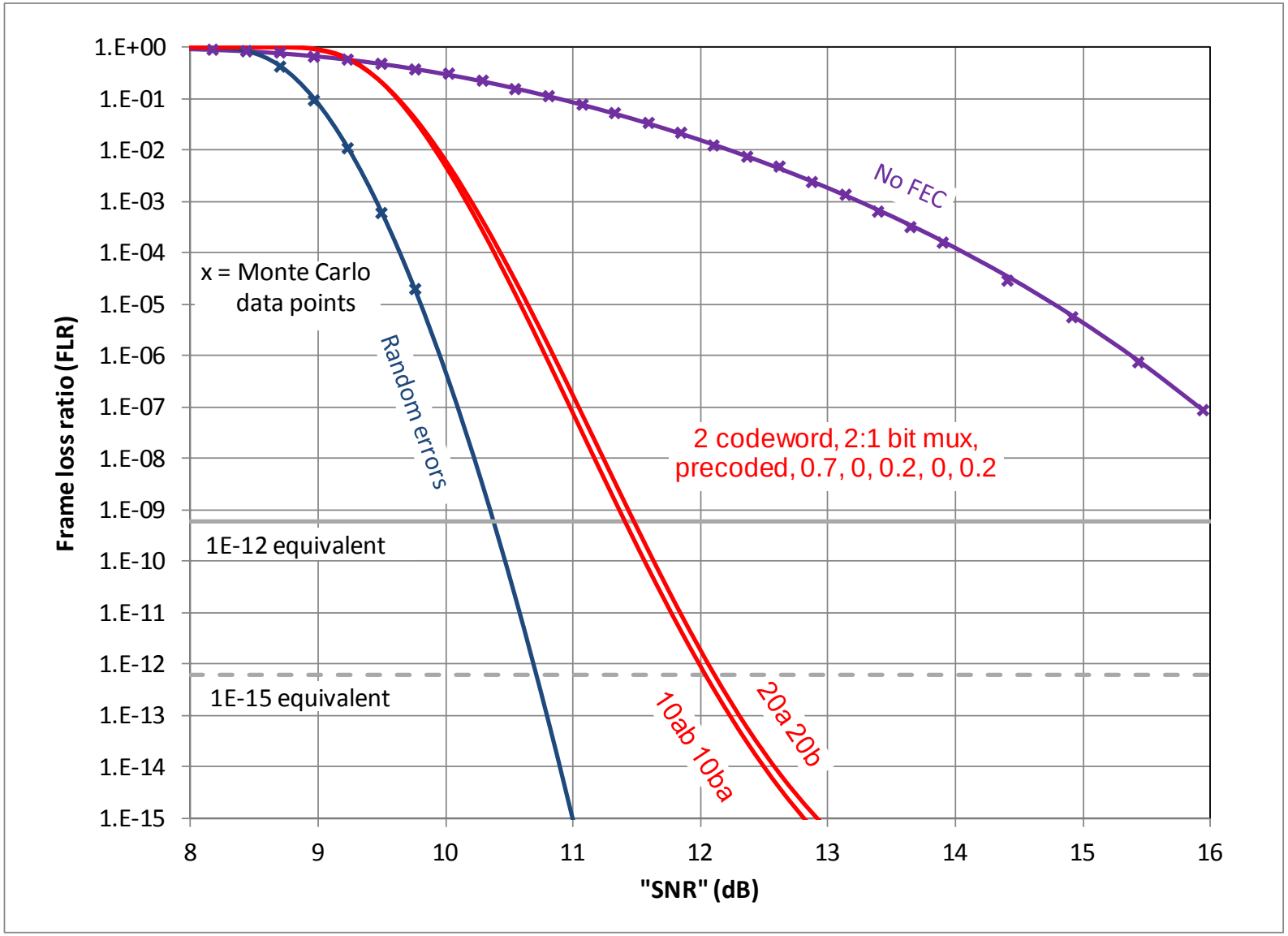
100G symbol interleaved to 2 lanes with bit mux PMA

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

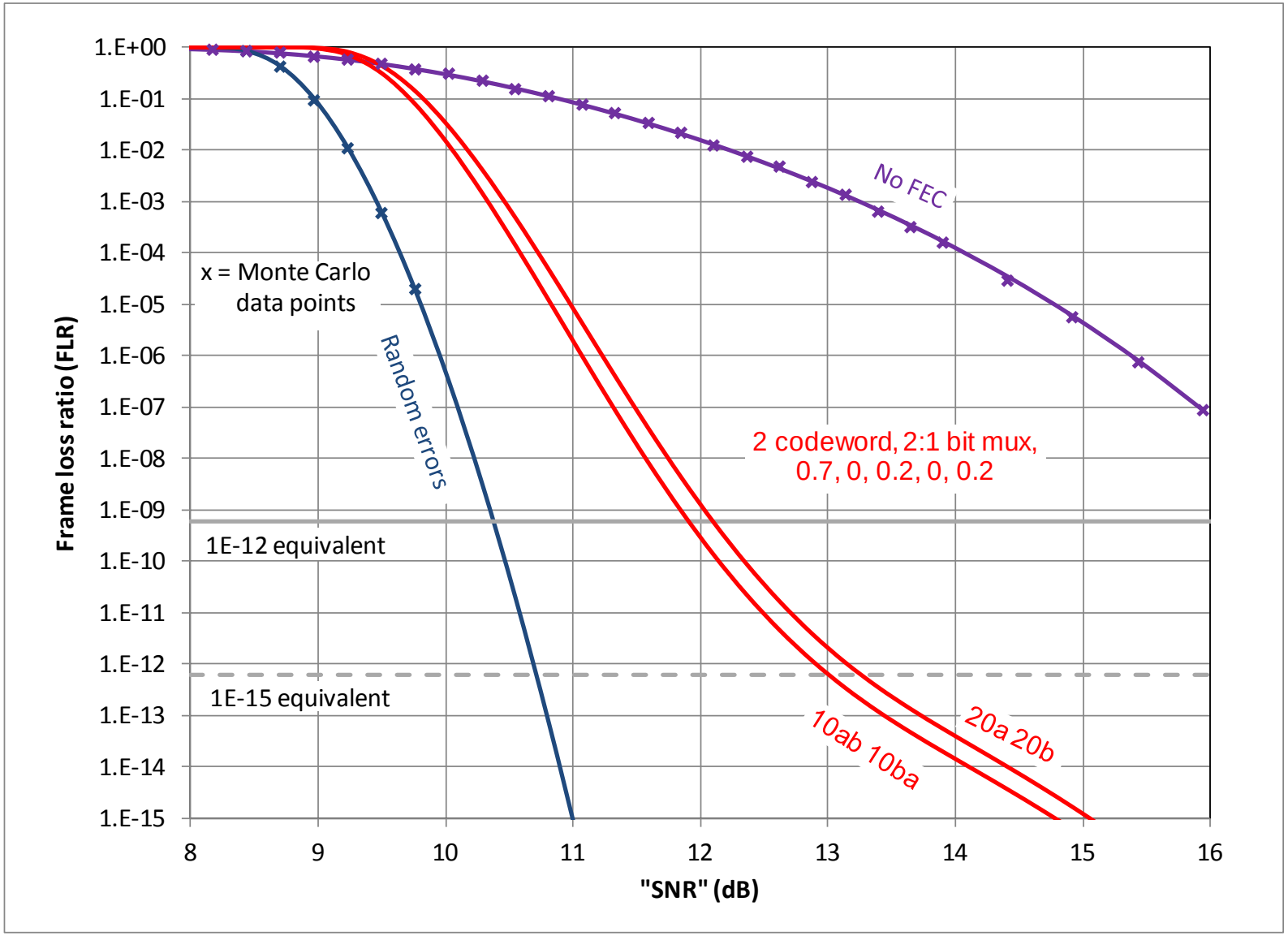


If one codeword is uncorrectable, the other is marked bad also.

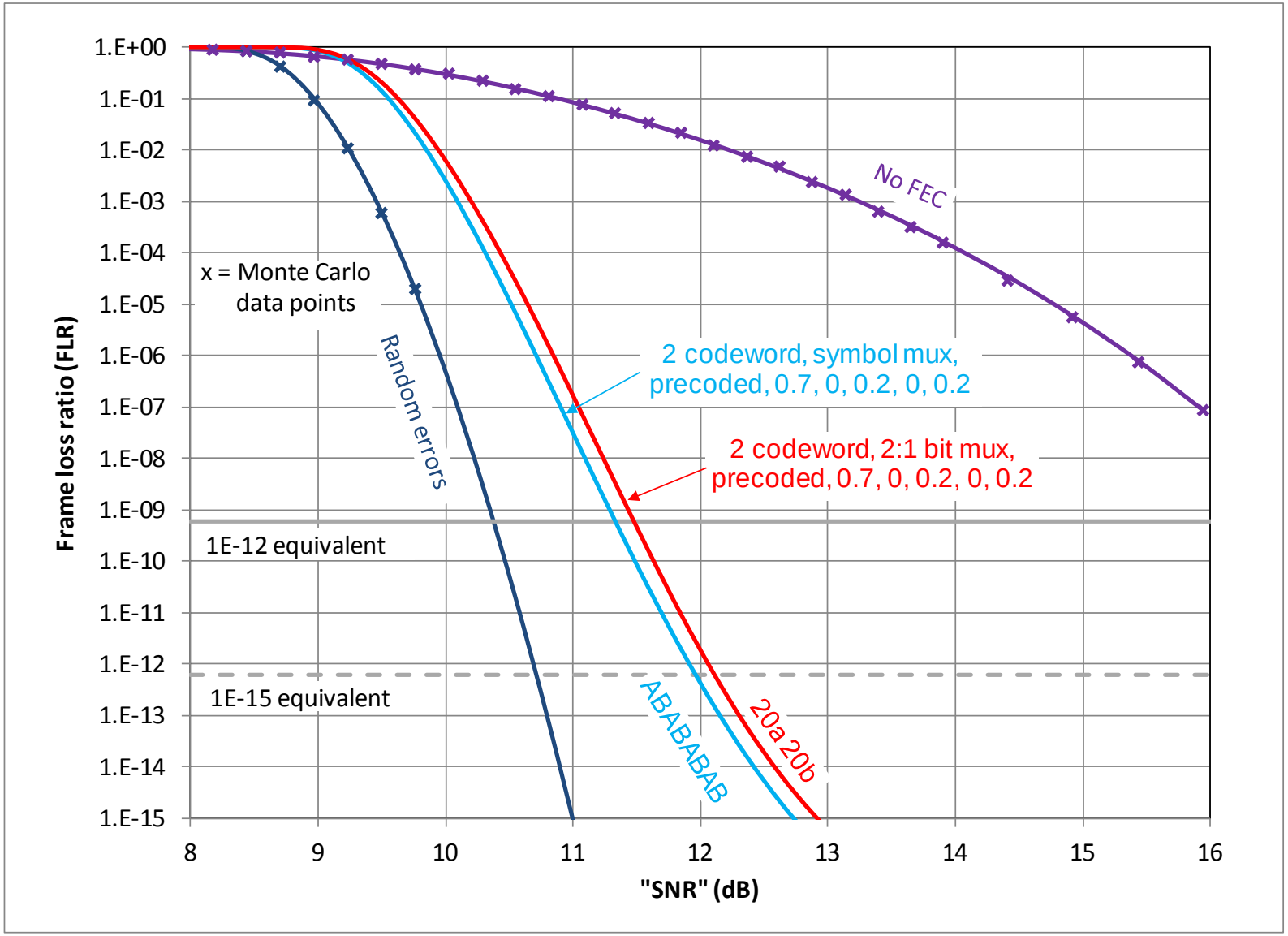
100G 2 lanes with 5-tap DFE (0.7, 0, 0.2, 0, 0.2) with precoding



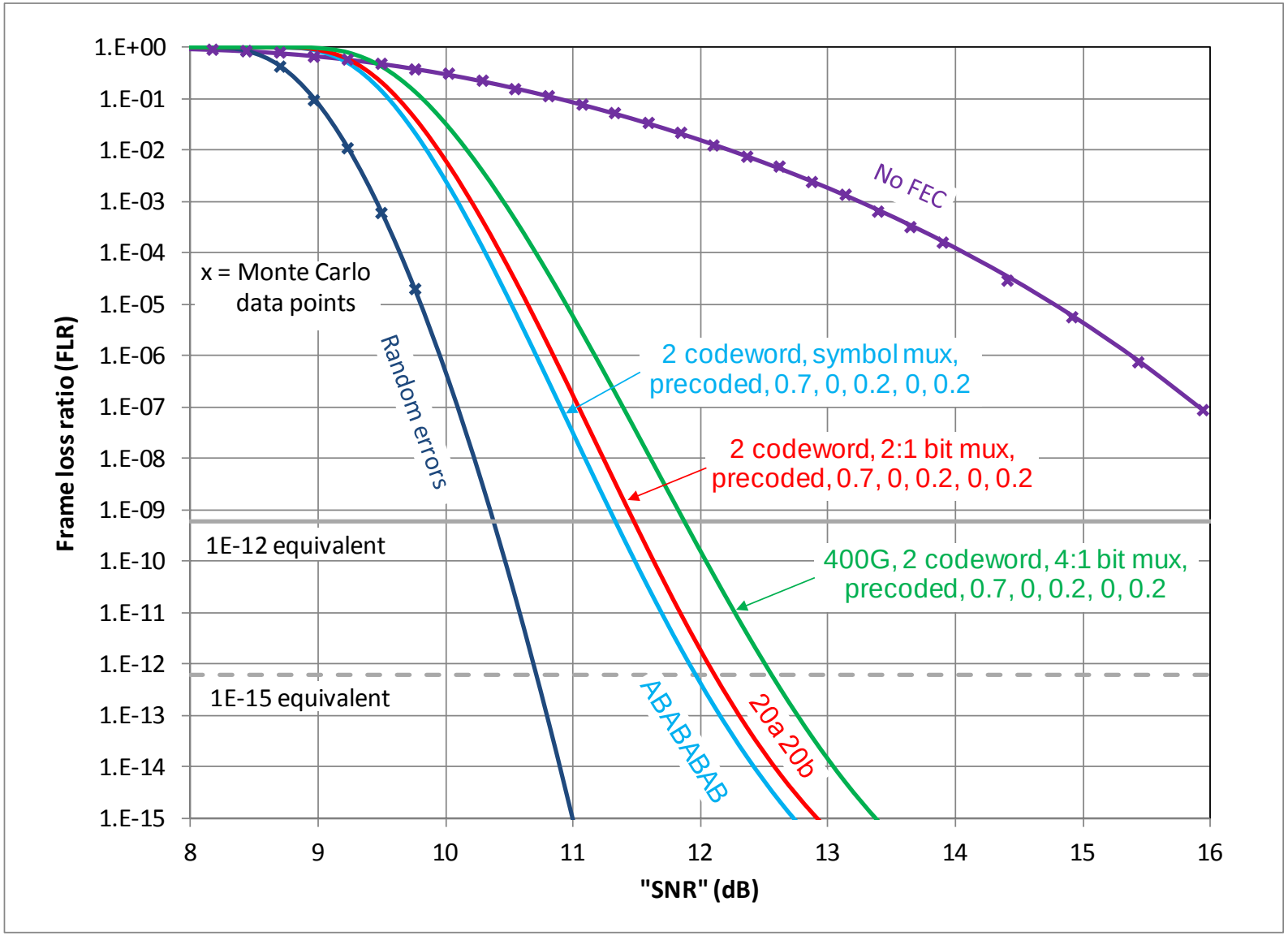
100G 2 lanes with 5-tap DFE (0.7, 0, 0.2, 0, 0.2) no precoding



100G compared (0.7, 0, 0.2, 0, 0.2) with precoding



100G compared (0.7, 0, 0.2, 0, 0.2) with precoding (400G added)



Results for RS(544,514) 100G all gain used for PAM4 part 1

From the curves shown on the previous pages, if all of the coding gain were to be used for the PAM4 link, the BERs required to give FLRs equivalent to that of a BER of 1E-12 (for 100G) or 1E-13 (for 400G) and 1E-15 are:

	BER at slicer output		BER at FEC input	
100G	FLR = 6.2E-10	FLR = 6.2E-13	FLR = 6.2E-10	FLR = 6.2E-13
No FEC	1E-12	1E-15		
2 codeword, symbol mux, precoded, 0.7, 0, 0.2, 0, 0.2	4.2E-4*	1.4E-4*	2.3E-4	7.7E-5
2 codeword, 2:1 bit mux, precoded, 0.7, 0, 0.2, 0, 0.2	3.3E-4*	1.1E-4*	1.8E-4	5.9E-5
Random errors	3.8E-4	2.3E-4		
400G	FLR = 6.2E-11	FLR = 6.2E-13	FLR = 6.2E-11	FLR = 6.2E-13
No FEC	1E-13	1E-15		
2 codeword, 4:1 bit mux, precoded, 0.7, 0, 0.2, 0, 0.2	1.1E-4*	4.2E-5*	6.0E-5	2.3E-5

Note – these values are the BER **including** the additional errors due to the bursts. To account for burst errors, the values marked with "*" have been multiplied by 4.42 for the 0.7, 0, 0.2, 0, 0.2 case.

Results for RS(544,514) 100G all gain used for PAM4 part 2

From the curves shown on the previous pages, if all of the coding gain were to be used for the PAM4 link, the SER_{in} and SNR required to give FLRs equivalent to that of a BER of 1E-12 (for 100G) or 1E-13 (for 400G) and 1E-15 are:

100G	For FLR = 6.2E-10			For FLR = 6.2E-13		
	SER_{in}	SNR (dB)	SNR + 6.99	SER_{in}	SNR (dB)	SNR + 6.99
2 codeword, symbol mux, precoded, 0.7, 0, 0.2, 0, 0.2	2.3E-4	11.3	18.3	7.7E-5	11.9	18.9
2 codeword, 2:1 bit mux, precoded, 0.7, 0, 0.2, 0, 0.2	1.8E-4	11.4	18.4	5.9E-5	12.0	19.0

400G	For FLR = 6.2E-11			For FLR = 6.2E-13		
	SER_{in}	SNR (dB)	SNR + 6.99	SER_{in}	SNR (dB)	SNR + 6.99
2 codeword, 4:1 bit mux, precoded, 0.7, 0, 0.2, 0, 0.2	6.0E-5	12.0	19.0	2.4E-5	12.5	19.5

Where:

SER_{in} is the symbol error ratio due to noise only (does not include bursts)
SNR (dB) is the “SNR” in equation (1) on page 25
SNR + 6.99 is the SNR as defined on page 5 of healey_100GEL_01_0318

Conclusion

Changing the 100G coding scheme to one that employs interleaving from two codewords improves the performance with precoding and a multi-tap DFE such that it is better than that for 400G.

The best performance is obtained for pure FEC symbol muxing (slide 3).

Forming two lanes and then bit muxing these together to form the 100G lane (as per slide 5) is only slightly worse (0.15 dB) for a 5-tap DFE with taps 0.7, 0, 0.2, 0, 0.2.

Thanks!