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Enhanced FEC consideration for 100G EPON

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Introduction

- From January meeting，“more complex” FEC “seems” to be suggested in 100G EPON[1].
- The purpose of this presentation is to initiate generic discussion of using enhanced FEC to help 100G EPON power budgets, no plan to reach any concrete conclusion at this stage.
- These slides address the following FEC issues:
  - Enhanced FEC coding gain
  - Power budgets with enhanced FEC
  - Enhanced FEC candidates

[1] M. Hajduczenia,“Baseline proposals for NG-EPON PCS”, hajduczenia_3ca_1_0116

FEC Coding Gain-1

- Coding Gain:

$$Coding\_Gain = 20\log_{10}\left|erfc^{-1}(2B_{ref})\right| - 20\log_{10}\left|erfc^{-1}(2B_{in})\right| \quad (\text{dBe})$$

Where erfc^{-1} is the inverse of the complementary error function, and B_{ref} and B_{in} are the input and output BER for a decoder, respectively.

- Taken as an example, RS(255,223) with bit error correcting ability of B_{in}=1.0e-3 @ B_{ref}=1.0e-12 has a coding gain of 7.1dBe.

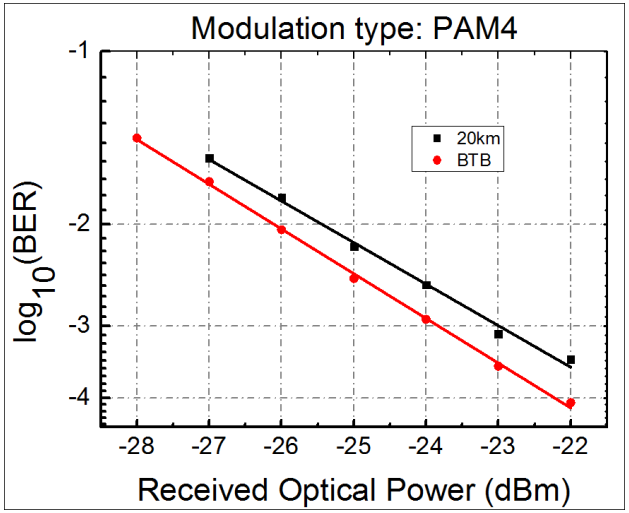
- If an enhanced FEC with higher bit error correcting ability, e.g., B_{in}=1.0e-2 @ B_{ref}=1.0e-12, we can find that the coding gain can be enhanced from 7.1dBe to 9.6dBe.

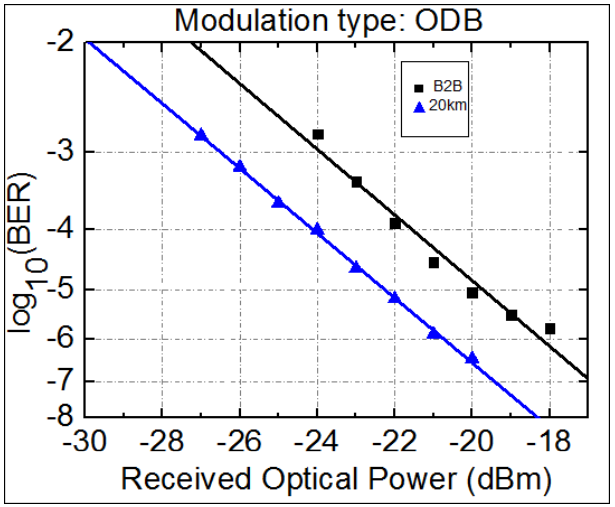
FEC Coding Gain-2

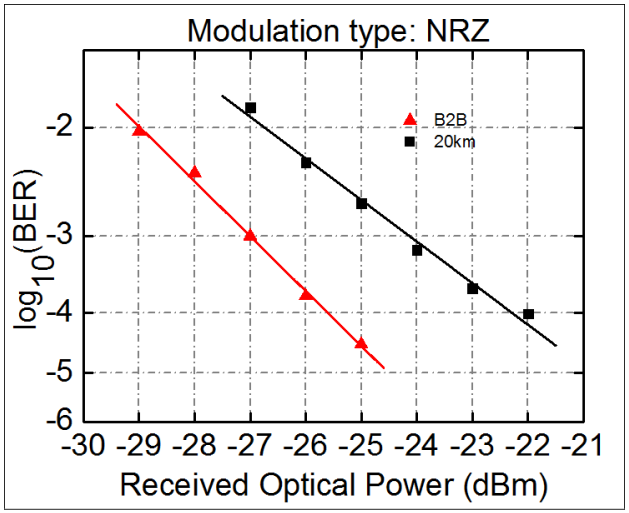
- Relationship between Optical and Electrical coding gain
  – PIN : Gain dBo ≈ ½ Gain dBe
  – APD: Gain dBo ≈ 1 Gain dBe (Theoretically)

- With the help of enhanced FEC, 2.5dBo additional power budget gain can be achieved theoretically for APD.

FEC Optical Gain: an example





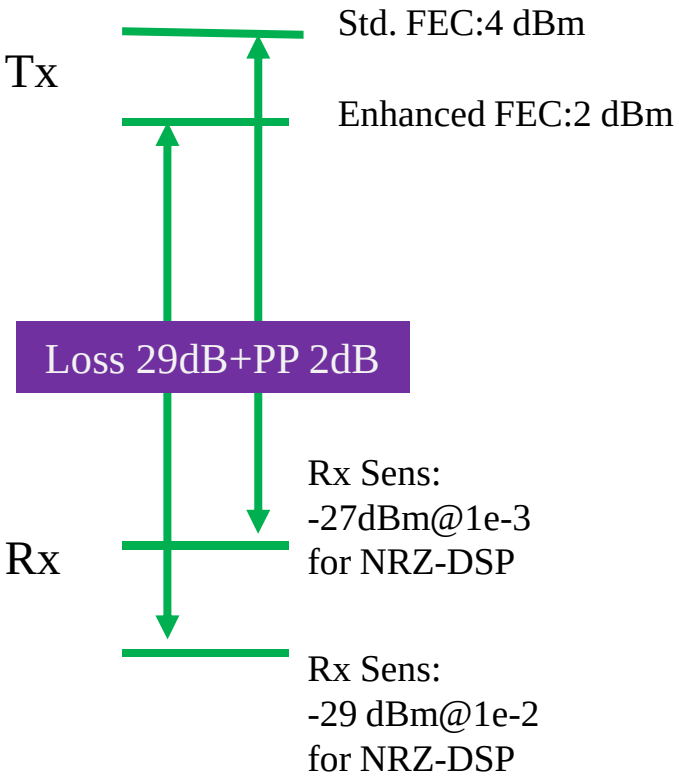


Some latest research[1-3] in 100G EPON confirm that at least 2dBo additional optical gain can be obtained if the input BER increases from 1e-3 to 1e-2.

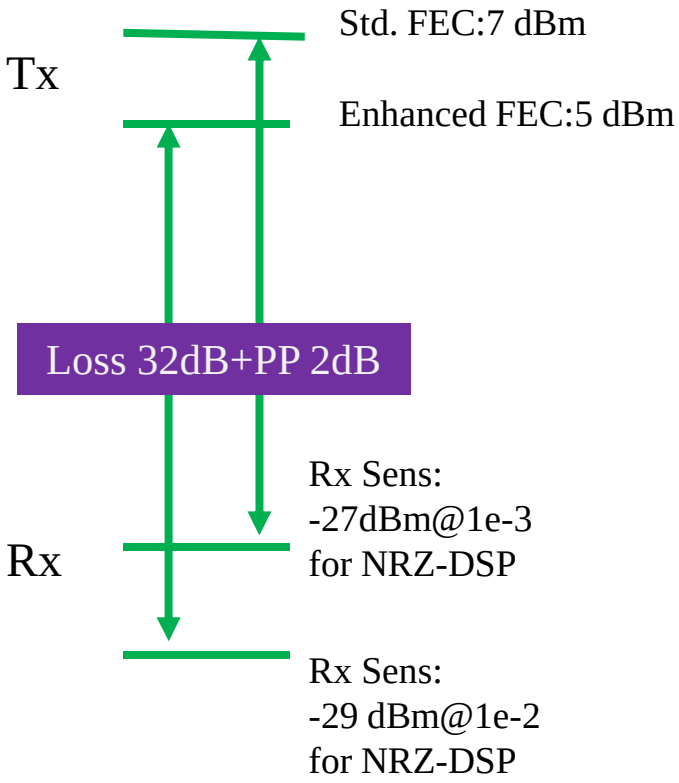
[1] OFC 2016, Th1I.2 Jianhe Gao, Ning Cheng, Hongguang Zhang
[2] Ecoc 2015 –ID :0050 Zhicheng Ye, Shengping Li, Ning Cheng, Xiang Liu
[3] OFC 2016, Th1I.4 M.Tao, L. Zhou, S,Yao, S,Li Xiang Liu

Power budgets: a 29/32dB example

29dB loss budget



32dB loss budget



Enhanced FEC example

Gen.	FEC code	Decision	Code rate	Bin	Coding Gain @e-12
1st	RS(255,223)	Hard	0.87	1.0e-3	7.1
	RS(255,151)	Hard	0.59	1.0e-2	9.6
2nd	Concatenated code, e.g., RS(248,216) + BCH(1023,873)	Hard	0.74	1.0e-2	9.6
3rd	Staircase product code[1], e.g., BCH(254,228) + BCH(254,228)	Hard	0.8	1.4e-2	10.1
	LDPC(37248,33024) • LDPC codeword length is bit order and error floor is not observed above e-14	Hard	0.89	6.0e-3	8.9
		Soft	0.89	1.2e-2	9.9
	…				

[1] B. Smith, A. Farhood, A. Hunt, F. Kschischang, and J. Lodge, “Staircase codes: FEC for 100 Gb/s OTN,” *J. Lightw. Technol., vol. 30, no. 1,* pp. 110–117, 2012

Final thoughts

- An enhanced FEC is able to help 100G EPON reach higher power budgets, e.g., 29dB->32dB

- It is possible to find an enhanced FEC with higher code rate (>=0.87) and higher coding gain (>=7.1dB) than RS(255,223)

Thank you

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