Optical source and FEC code for 25G-EPON

Hanhyub Lee, and Hwan Seok Chung

IEEE P802.3ca 100G-EPON Task Force
July 09-14, 2017
Berlin, Germany

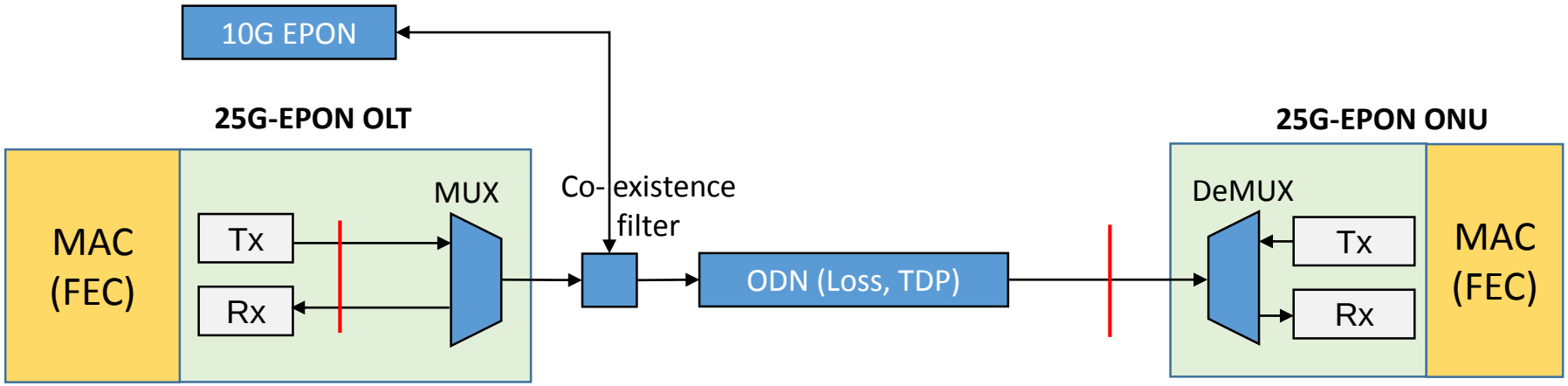
Motivation

- To satisfy 100G-EPON power budget, SOA (Booster amplifier and preamplifier) will be a good solution to support PR30 link budget with addition loss from TDP and optical filters.
  - ➢ Booster amplifier can increase a downstream power/channel over 9 dBm
  - ➢ Pre amplifier can improve a receiver sensitivity below -29 dBm

  http://www.ieee802.org/3/ca/public/meeting_archive/2017/07/lee_3ca_1_0717.pdf

  http://www.ieee802.org/3/ca/public/meeting_archive/2017/07/lee_3ca_2_0717.pdf
- In this case, 100G-EPON can use the same FEC code of 10G-EPON.
- In the 25G-EPON case, it is not desirable to use SOAs in the OLT considering a low-cost solution.
- In this contribution, we discuss about a complementary approach to compensate an additional link loss in the 25G-EPON.

Downstream link loss and required Tx power



	Tx power	MUX	CEX	ODN	TDP	Rx sensitivity
Optimistic	6.8	0.5	0.5	29	1	-24.2
Pessimistic	7.7	0.7	0.7	29	1.5	-24.2

- Considering characteristics of ONU receiver sensitivity, link loss, TDP and extra filters the OLT Tx output power have to be 6.8 dBm or 7.7 dBm
- From the previous survey results, the EML output power will be expected 4 dBm or 4.5 dBm in 2020. There are 3.7 dB or 2.3 dB of gap.
- How to compensate the maximum 3.7 dB of gap is the question.

Enhanced FEC

Comparison of suitable codes proposed thus far
Using ideal AWGN-model (only random errors)

*) Assuming APD-based receiver with 1 dBe = (0.7-0.9) dBo

FEC code	OH (%)	FEC Gain (dBe) @BERout =1e-12	BERin for BERout =1e-12	Optical gain delta relative to RS(255,223) (dBo)*	Length (bits)	Burst errors Capable (bits)	Power consumption	Complexity	Latency
RS(255,223)	12.5	7.1	1.1e-3	0	2040	121	low	low	low
RS(1023,847)	17.2	8.5	4.2e-3	1-1.3	10230	871	med	low	low
RS(2047,1739)	*15*	*8.5*	*4.1e-3*	*1-1.3*	*22517*	*1684*	*med/high*	*med*	*med*
BCH(4095,3501)	14.5	8.5	4e-3	1-1.25	4095	49	med	low	low
LDPC(16000,13952)	13	8.9	5.8e-3	1.25-1.6	16000	?	high	high	high
LDPC(19200,16000)	17	9.6	1e-2	1.75-2.25	19200	?	high	high	high
Folded product BCH	17	9.7	1.1e-2	1.8-2.35	16384	?	?(<LDPC)	?	?

We have to be careful when comparing FEC gain relative to RS(255, 223) for alternative codes that have shorter burst error capabilities.
Coding gain improvement might turn out smaller than expected!

13

Public

NOKIA

http://www.ieee802.org/3/ca/public/meeting_archive/2017/03/vanveen_3ca_1a_0317.pdf

- It is impossible to overcome the gap of 3.7 dB even strong LDPC code.
- There is still 1.5 dB of gap if LDPC(19200, 16000) is applied to the 25G-EPON FEC.

High power optical source

25G transmitter launch power and ER responses

	25G EML		25G cooled DML		25G uncooled DML		25G EML+SOA	
	Power (dBm)	ER (dB)	Power (dBm)	ER (dB)	Power (dBm)	ER (dB)	Power (dBm)	ER (dB)
vendor 1	3~4	8	7	4.5	5~6	4.5	7 (note 1)	8
vendor 2	3	8	5	5	4	4	7	8
vendor 3	4	6	4	4	xx	xx	6~7	6
vendor 4	2.5	8	5.8	4	xx	xx	xx	xx
vendor 5	4.3	8	5.5	4.5	4	4	7	7
vendor 6	4.5	8	6	5	4	4	x	x

Note 1: Proposed to add one more option 10~11dBm with the relative cost ~20 (Assuming develop a new device specially optimized in future)

HUAWEI TECHNOLOGIES CO., LTD. 4 HUAWEI

http://www.ieee802.org/3/ca/public/meeting_archive/2017/05/liudekun_3ca_4_0517.pdf

- It is impossible to overcome the gap of 3.7 dB by using the 25G EML+SOA only.
- If 25G EML + SOA will be used then the gap will be decreased from 3.7 dB to 0.7 dB.
- 0.7 dB of gap can be overcome by using the enhanced FEC such as RS (1023, 847) or LDPC (16000, 13952).

Conclusions

- We discussed a loss compensation option for 25G-EPON without using the SOA.
- It seems to be impossible to compensate the 3.7 dB of gap by using the enhanced FEC or EML+SOA source only.
- Hybrid approach (EML+SOA+enhanced FEC) will be needed to overcome the gap.
- RS (1023, 847) or LDPC (16000, 13952) will be a candidate as the enhanced FEC code. The RS code would be better considering their power consumption, complexity and latency.
- The other candidate is to use optical receiver with better sensitivity.
  - http://www.ieee802.org/3/ca/public/meeting_archive/2017/03/pan_3ca_1_0317.pdf