Improving 25G-EPON sensitivity

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Introduction

The 802.3ca Task Force has decided 25G-EPON ONU receiver sensitivity of -24.2 dBm at BER = 1E-3 and ER = 8 dB as a starting point. (Motion #3 in Huntington Beach).

This is apparently not enough for 25G-EPON system, since it puts lots of pressure on Tx side. At least +6dB Tx power for 25G EML is required without SOA, which is very hard to achieve (+4dBm is more reasonable as mentioned in liudekun_3ca_4_0517).

There are still many efforts we should try to use to improve 25G sensitivity in order to avoid expensive amplifiers and complex enhanced FEC.

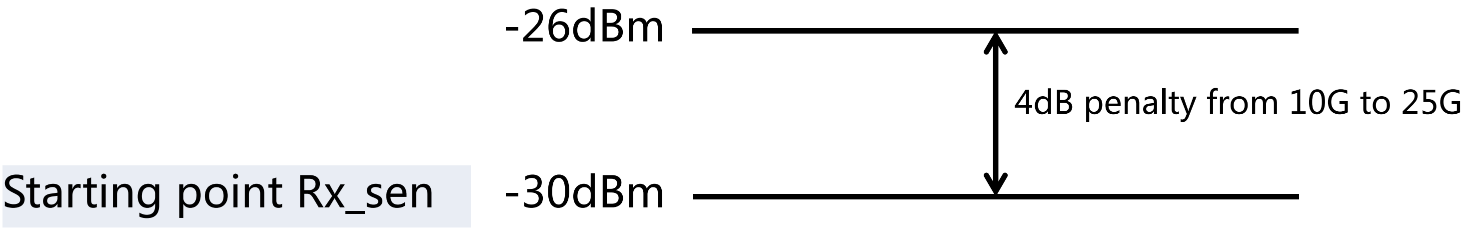
- Using improved 10G APD performance as deriving baseline
- Using high performance O-band 25G Ge/Si APD
- Using 10G receiver assisted by DSP-based equalizer

#1 Improved 10G APD deriving baseline

Let's take -29dBm OLT sensitivity which is used in XGS-PON (between N2 and E1) under 1E-3 and ER at 6dB as the deriving baseline.

- If in continous mode, sensitivity could be better, assuming 0.5dB is enough.
- If ER is improved to 8dB, sensitivity could also be improved, also assuming 0.5dB (tanaka_3ca_1_1116).
- Then at lease 1dB sensitivity improvment can be achieved.
- In fact, -30dBm has been measured by most of our vendors. We believe it can be provisioned to market in few years.

If we consider 4dB 10G to 25G loss, and even consider 1dB margin, then there will be 1-2dB improvement of -24dBm as motioned in previous meetings.



#2 Using high performance Ge/Si APD

Many experiments and demonstrations showed Ge/Si APD offers better performance at high data rate.

It is believed that by using Ge/Si technology there will be 1-2dB improvement for 25G receiver sensitivity by the time of commerial deployment for 25G-EPON.

Parameter at 25ºC	Ge/Si APD (now)	Ge/Si APD (improved TIA)
BER	1.00E-03	1.00E-03
Q factor	3.09	3.09
Extinction ratio (dB)	8	8
Dark current @M=1 (nA)	60	60
Responsivity @M=1 (A/W)	0.7	0.7
Ionization coefficient ratio @M=12	0.13*	0.13*
Bandwidth @M=12 (GHz)	22	22
25G TIA input RMS noise (μA)	2	1.4
APD shot noise (μA)	1.83	1.65
Receiver total RF noise (μA)	2.71	2.16
25G AOP Sensitivity (dBm)	-28.6	-29.6

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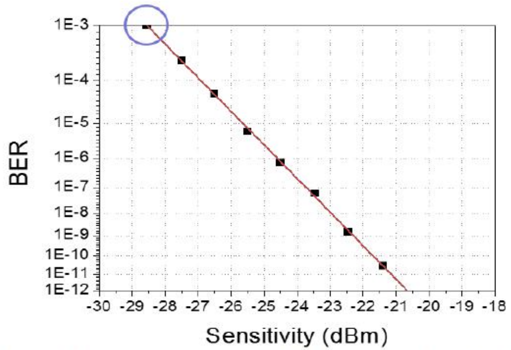

Back-to-back sensitivity of Ge/Si APD TO-can ROSA (λ=1309.14nm, ER=9.5dB, 25.78Gbps, 2^31-1, NRZ, w/o CDR, 25ºC)

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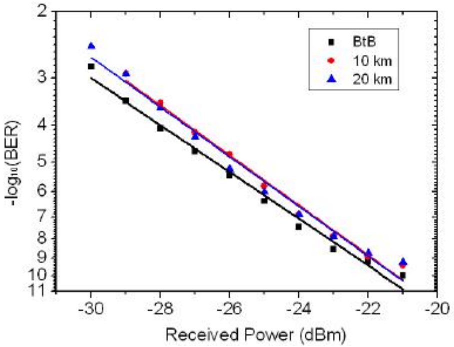

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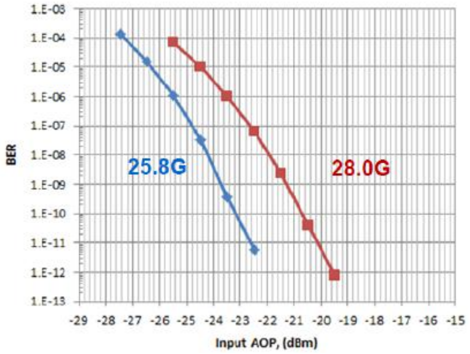

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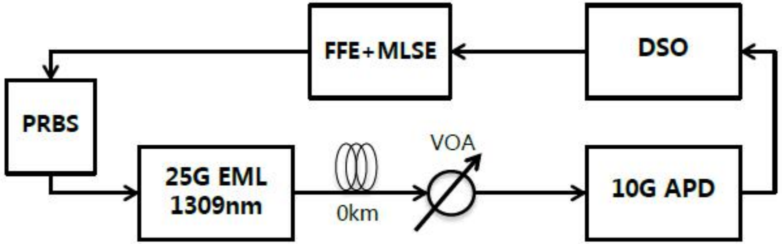
#3 Using 10G APD assisted by DSP-based equalizer

Many contributions and experiments showed 10G receiver could provide at least 1-2dB improved sensitivity assisted by DSP-based equalizer (FFE+MLSE) because of lower noise.



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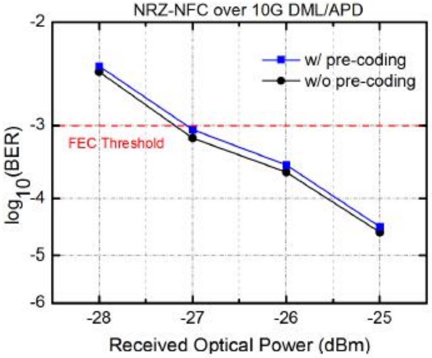

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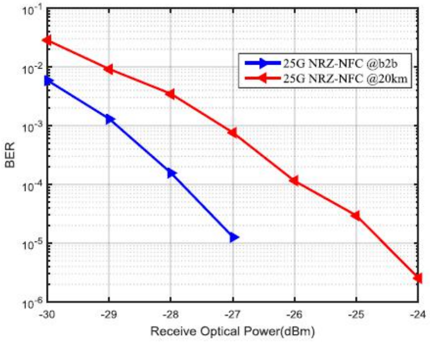

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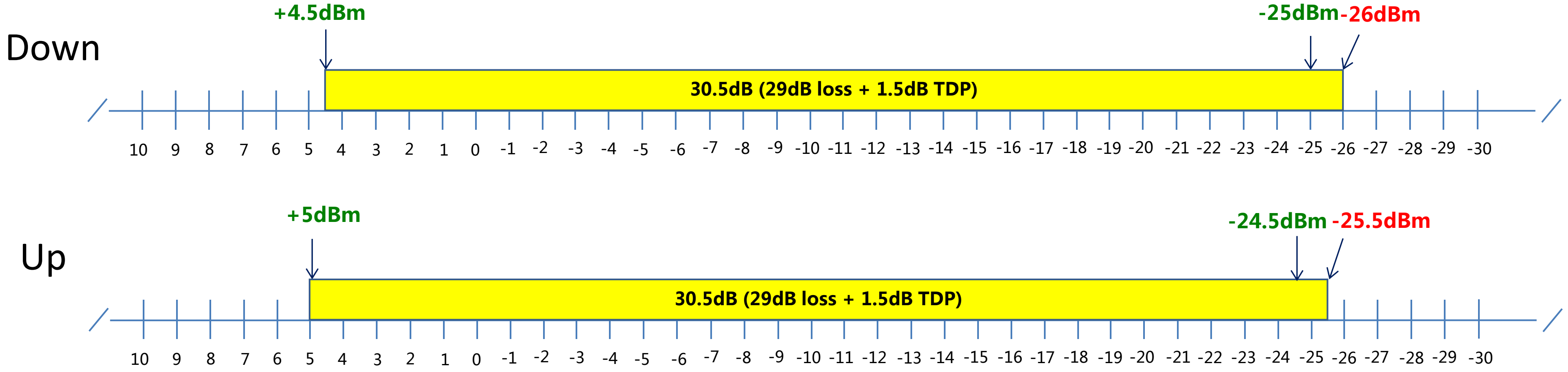
	10G APD (FFE+MLSE)
Transmitter	25G EML
Rx Equalizer	FFE+MLSE
Rx electronics	ADC+DSP
Rx linearity	Linear
Sensitivity at BER 10^{-3}	-26dBm
Electronics complexity	High

25G-EPON power budget proposal (PR30)



- Assuming 1.5dB TDP for both downstream and upstream
- dowstream ONU sensitivity is proposed 1dB better than -24dBm (-25dBm) at 1E-3
- upstream OLT sensitivity (BM) is proposed 0.5dB worse than downstream (-24.5dBm)
- RS with longer code word (such as RS(1023, 847) in laubach_3ca_1_0517) is proposed to provide additional 1dB gain at 4E-3 in order to further relieve Tx power.
- min Tx power for downstream is +4.5dBm and min Tx power for upstream is +5dBm

Summary

In this presentation we propose several ways to enhance 25G receiver sensitivity.

- #1 improve 10G APD deriving baseline
- #2 using high performance Ge/Si APD
- #3 using 10G APD assisted by soft decision equalizer
- and stronger RS FEC with longer code word
- by above methods, we can get +1dB sensitivity and +1dB coding gain to close the 2dB gap

Achievable PR30 power budget for 25G-EPON is proposed with feasible Tx power level and Rx sensitivity without expensive amplifiers and complex FEC.

- downstream: +4.5dBm EML Tx power, ER=8, -26dBm sensitivity at 4E-3
- upstream: +5dBm DML Tx power, ER=6, -25.5dBm sensitivity at 4E-3

Thank you

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