Security Level:

100G EPON downstream solution analysis and comparison

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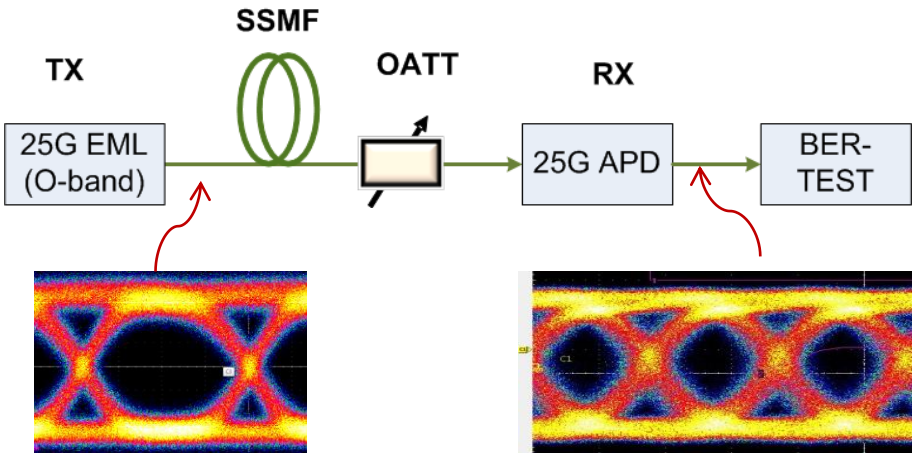
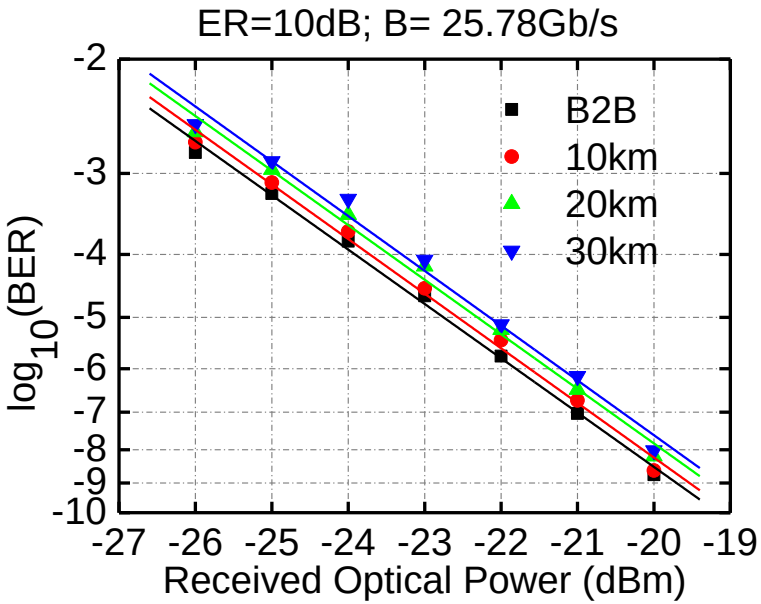
Background

- Putting all 8 wavelength in O-band seems to be challenging (may required cooling, collimated beam, very narrow guard band ONU …)
- O minus band will most likely be left for upstream, which enables low cost DML transmitters for ONU
- PMD CFC requests information on component combinations analysis needed for various modulation schemes
- This contribution analyzes some possible solutions for the downstream link and compares the performance-cost ratio for:
  - O+ band NRZ
  - S/C/L band electronic duo binary
  - S/C/L band optical duo binary

Option 1: O+ band 25G EML NRZ + 25G APD

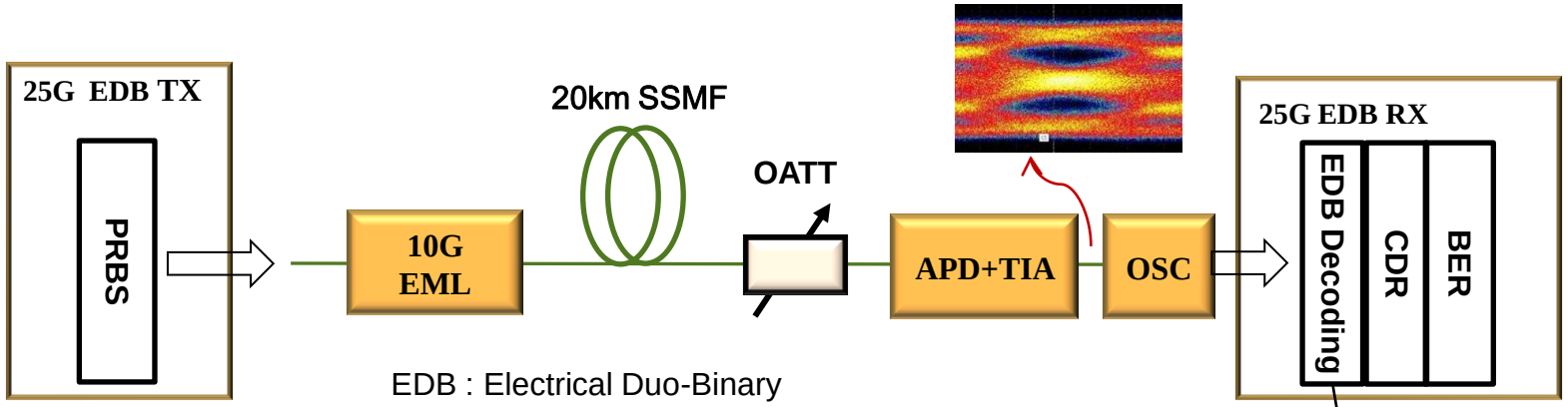
25.78 Gb/s NRZ (based on 25G EML+25G APD)



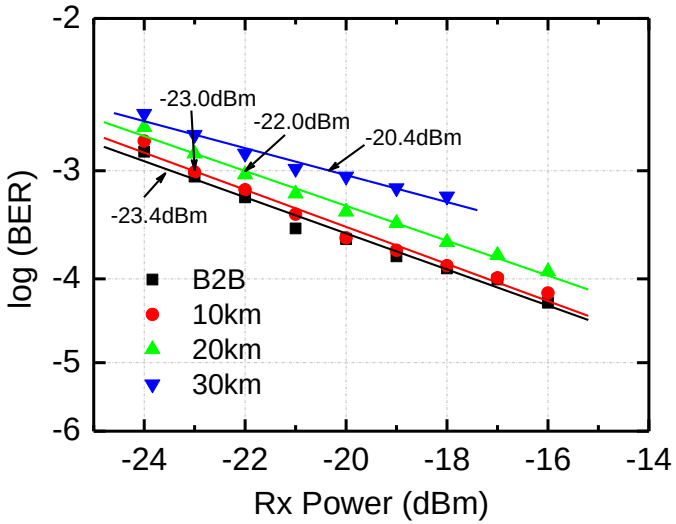


- Key components : 25G EML laser, 25G APD
- Key advantage: NRZ modulation, high receive sensitivity **: -25.4 dBm @BER=1E-3 (B2B)**

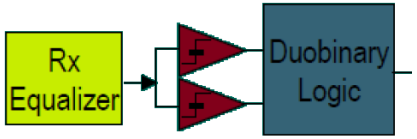
Option 2： C band10G EML EDB+10G APD



EDB : Electrical Duo-Binary



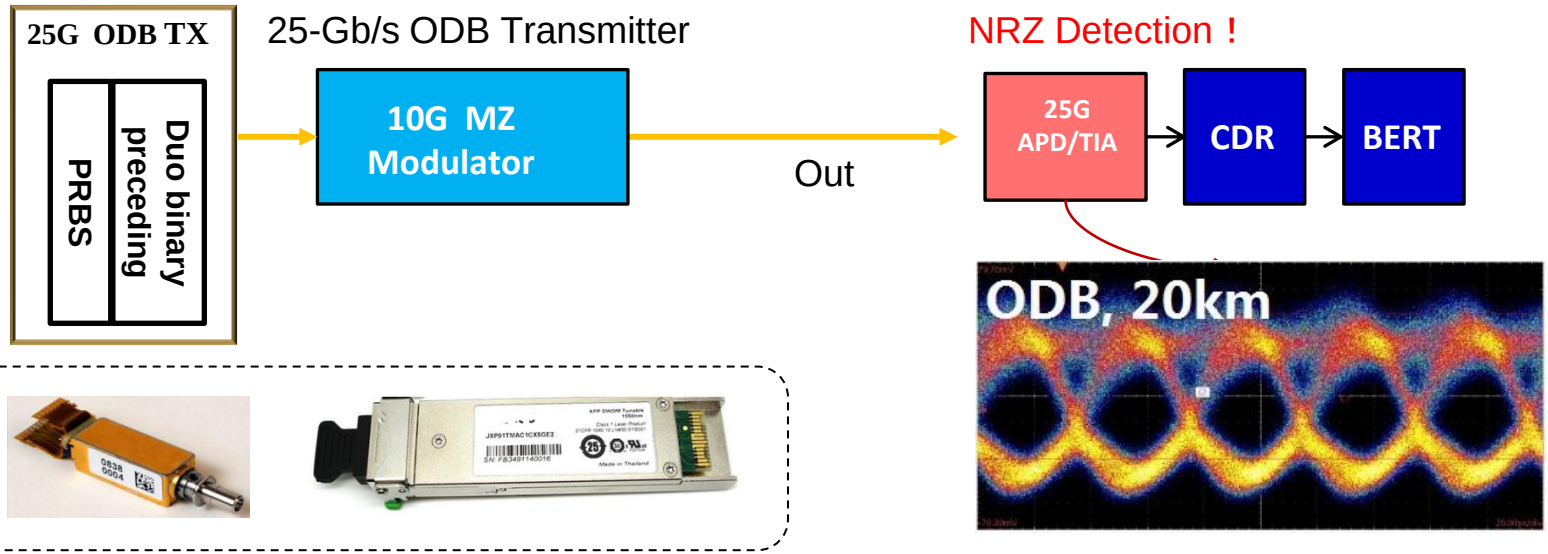
EDB Optics and Electronics Design	
Component	BW @ 3dB
10G EML	10 GHz*
10G APD	7.5 GHz



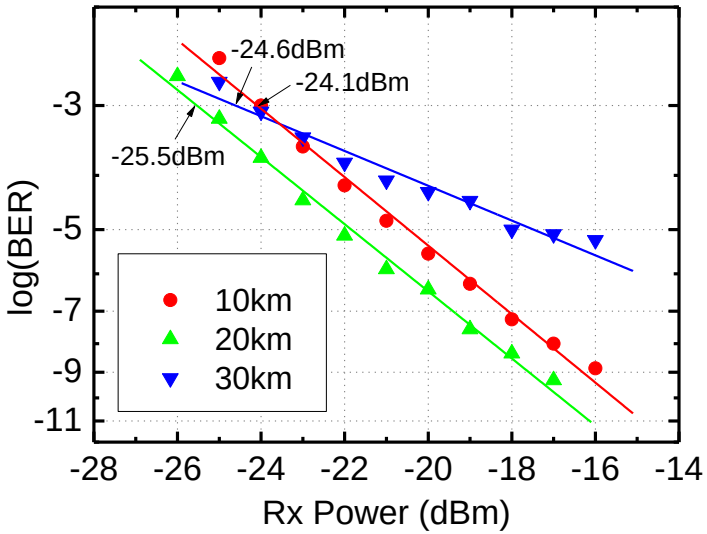
* Note :The typical 3dB bandwidth of current commercial 10G EML can be up to 10GHz.

- Key components : EDB decoding chip, 10G EML, 10G APD
- Key advantage: mature existing commercial 10G optics
- Main challenging : complex electronic (EDB decoding), relative lower sensitivity (~2dB lower)

Option 3： C band ODB+25G APD



InP based 10G DFB+ MZM +SOA integrated TOSA
Full Size: 7 x 5 x 17mm
Application with XFP, SFP+ MSA package
Commercial available in 10G Ethernet for 40km



- Key components : 10G MZM modulator
- Key advantage: ONU NRZ direct detection, anti-dispersion
- Main challenging : MZM modulator in OLT

A. Overview comparison

Attributes at 25 Gb/s	O+ band NRZ	C/S/L band EDB	C/S/L band ODB
OLT transmitter optics	25G EML (18.5GHz)	10G EML (10GHz)	10G MZM
OLT electronics	25G LDD	10G EDB LDD precoding	10G MZM LDD precoding
ONU Rx optics	25G APD (18GHz)	10G APD (7.5GHz)	25G APD
ONU Rx electronics	25G TIA	10G linear TIA EDB decoder	25G TIA
Rx sensitivity degeneration compared with NRZ (dB)	-	~-2 dB	~ -1 dB
Electronics simplicity	+++	+	++

B. The system cost comparison

	TX/RX	Cost Medium volume in near term	Cost high volume in long term	Bandwidth@ 3dB	Total cost by weigh* Near term	Total cost by weigh* Long term
10G EPON	10G EML Tx	1.67A	A	7.5GHz	1.67C	C (=A/20 + B)
	10G APD Rx	1.67B	B	7.5GHz		
25G NRZ	25G EML+SOA Tx	5A	3.2A	18 GHz	5C	2.3C
	25G APD Rx	5B	2B	18 GHz		
25G EDB	10G EML+SOA Tx	3A	1.67A	10 GHz	3.5C	1.7C
	10G APD Rx (linear TIA)	2B	1.2B	7.5 GHz		
	25G EDB Decoder	X (~ 1.67B)	X0 (~0.5B)	25 GHz		
25G ODB	DFB+10G MZM+SOA	5A (InP MZ based)	3.2A	8 GHz	5C	2.3C
	25G APD Rx	5B	2B	18 GHz		

Note : the total cost by weigh assume the volume ratio of OLT : ONU = 1 : 20

Summary

- Several options for 100G EPON downstream were analyzed and compared.
- There is no distinct cost difference between NRZ in O+ band and duo binary (EDB, ODB) in S/C band, due to :
  - Low bandwidth optics in duo binary save a lot of cost
  - “All present solutions in downstream need an amplifier” imply the lower sensitivity of duo binary is a less costly solution.
- EDB with low bandwidth optics have the lowest cost due to low bandwidth optics benefit
- ODB has a same ONU receiver with NRZ modulation.

Thank you

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