



Technical Feasibility to support beyond 10km on 400GbE

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Background

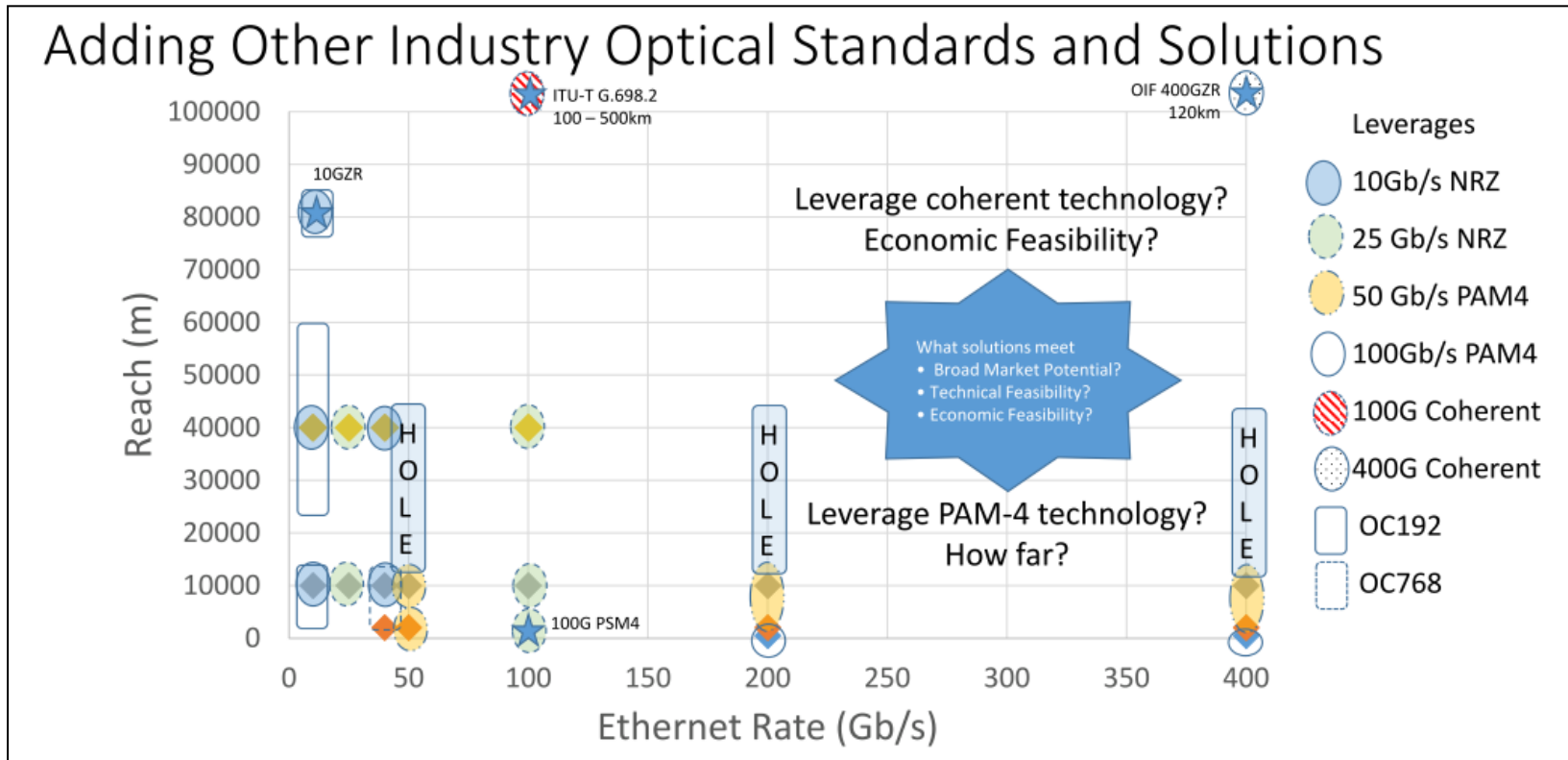


- In NEA Ad-hoc, we have confirmed the need for > 10km reach and also identified “solution hole” for 50GbE/200GbE/400GbE beyond 10km.
- According to the straw poll in Huntington beach meeting, Most is expecting we move forward for “Beyond 10km” CFI
- In this presentation, the technical feasibility is investigated for 400GbE Beyond 10km SMF PMD based on 50G PAM4.

Revisiting “Beyond 10km” in Jan



- Investigating on technical feasibility of PAM4 is needed for 400GbE with beyond 10km, such as 20km, 30km, 40km, etc.



[“dambrosia_nea_01_0117”](#)

Review: Technical approach for ER PMD



■ Optical transmission performance evaluation

([sone_ecdc_01b_0516](#))

400GBase-LR8 reach can be extended with some approaches

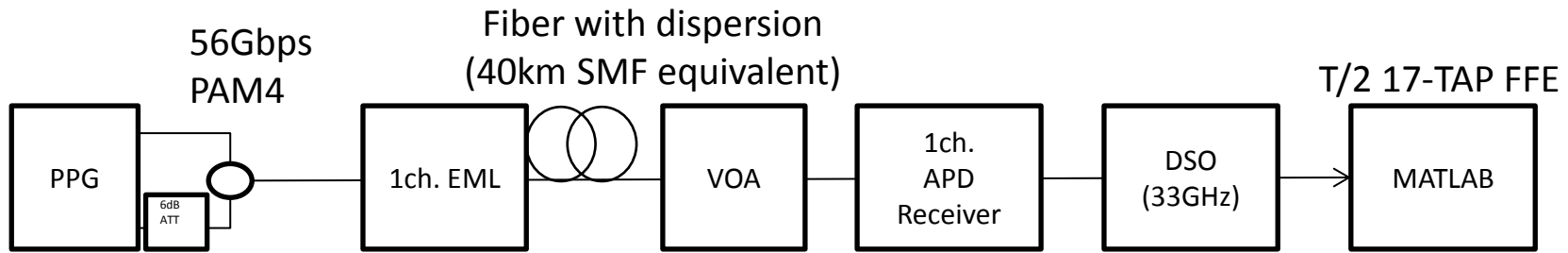
- 1) APD-receiver,
- 2) higher power EML
- 3) Stronger FEC

■ FEC options for extended reach 50G/200G/400GbE

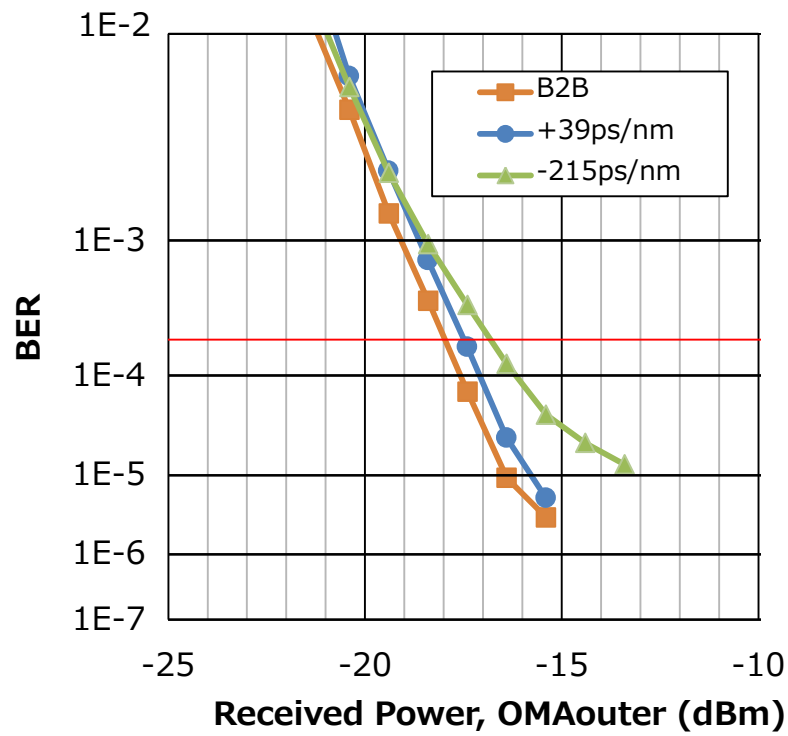
([wang_ecdc_01_0316](#))

Several stronger HD-FEC options exist other than KP4.

Receiver sensitivity with APD ROSA



Receiver sensitivity with APD-ROSA



56G PAM4 reach extension is achieved.

APD receiver can achieve rec. sensitivity of
-16.7 dBm for the worst case dispersion (neg.)*
-18.0 dBm for the worst case dispersion (B2B)
(* assumed 8-lane LAN-WDM over SMF)

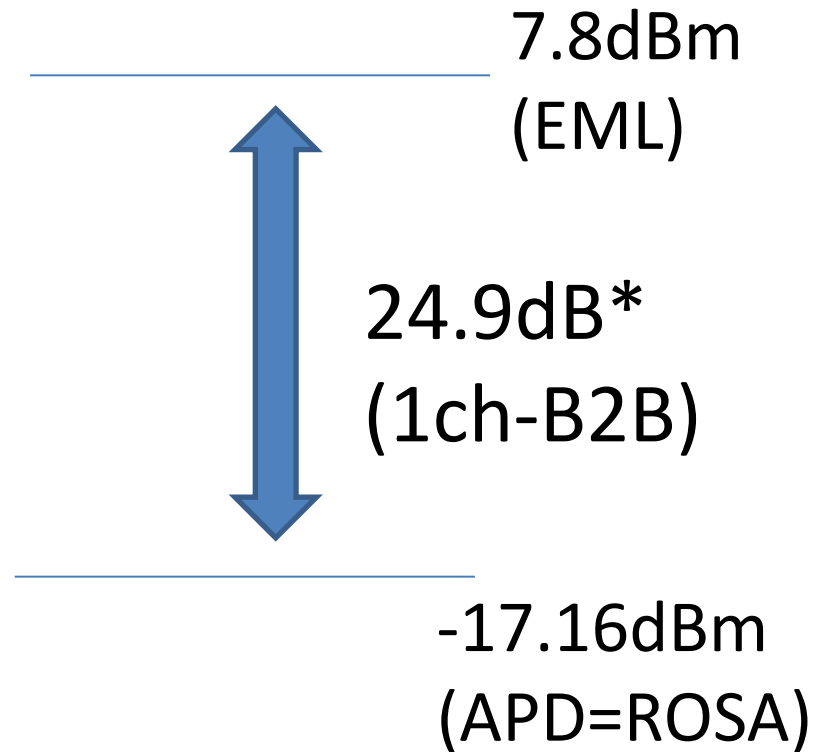
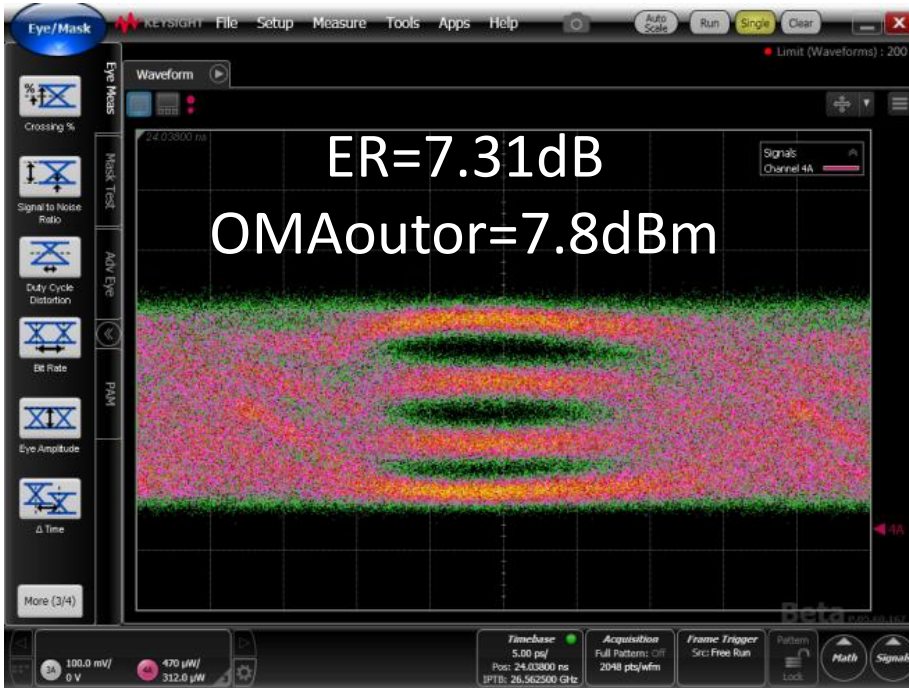
Assuming KP4 FEC but still 56Gpps can
Accommodate stronger FEC overhead.

Link budget example with High-power EML



Evaluation result using high power EML and APD-ROSA
Link-budget=24.9dB (1ch B2B, KP4 FEC limit)

PAM4 tx eye with high power EML

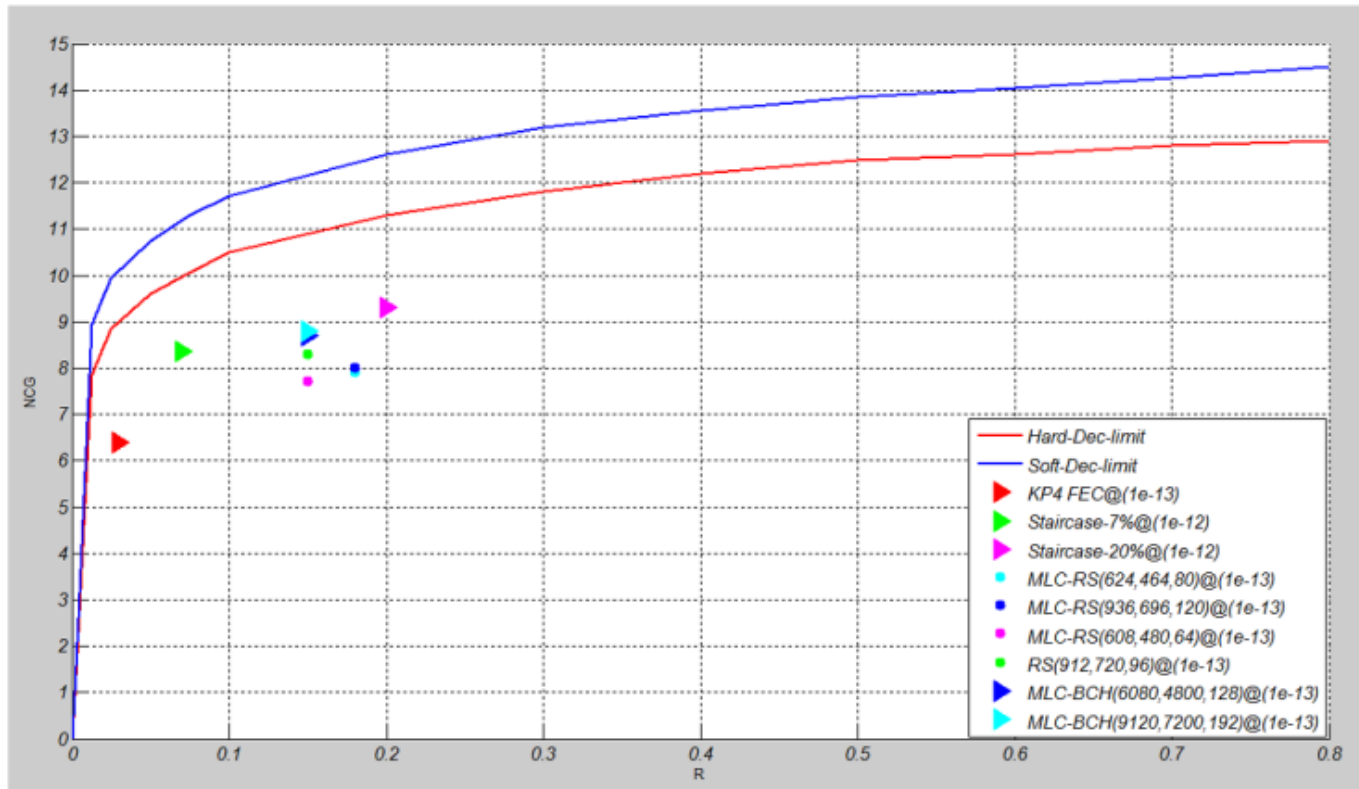


Beyond 10km :Stronger FEC



Several Potential HD-FECs with 8-9dB NCG can help to achieve beyond 10km 400GbE

RS-FEC, BCH-FEC, MLC-FEC or Staircase FEC. ([wang_ecdc_01_0316](#))

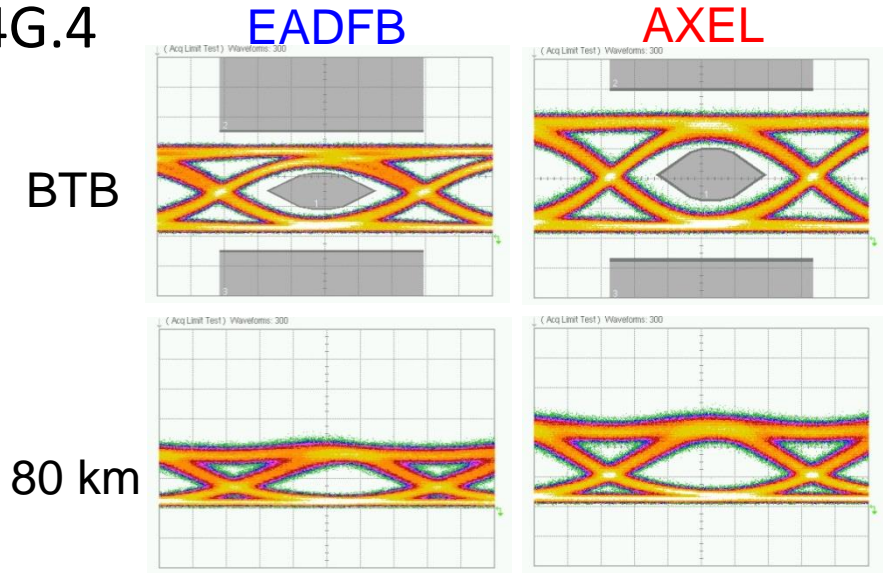
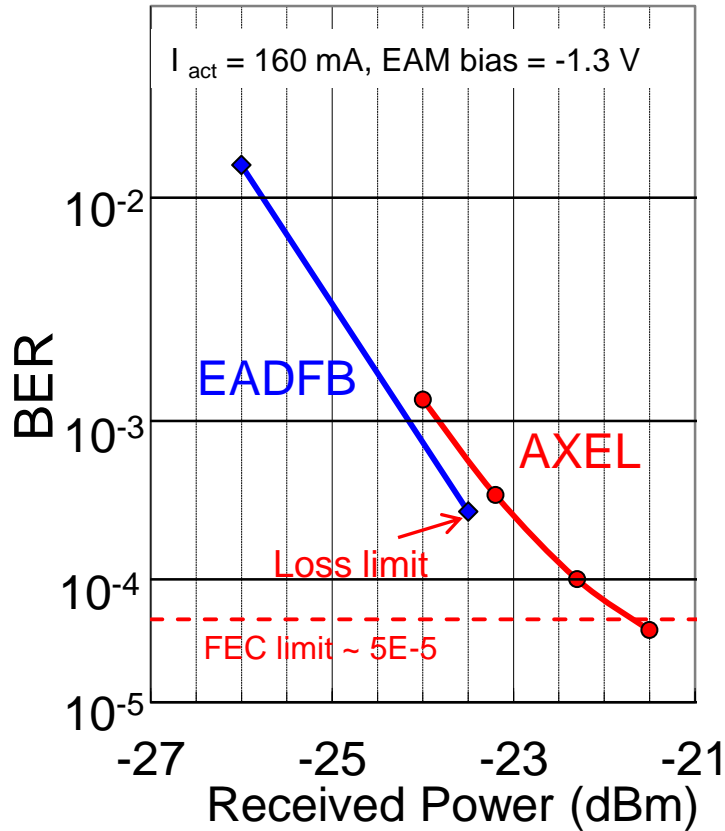


NCG for HG FEC options, Assuming post BER@1E-13 objective.

Emerging latest technology in OFC2017



Hasebe et.al, OFC2017, paper Th4G.4



Output power(dBm)	5.7	8.7
Extinction ratio (dB)	8.5	8.9
OMA (dBm)	7.5	10.4
Mask margin	8%	9%

Achievement: 28 Gbit/s, 80-km transmission
 Modulated average power $P_{avg} = 8.7 \text{ dBm}$

Summary



- From technical perspective, beyond 10km reach is feasible for 8x50G PAM4.
- The exact available maximum reach need to be further investigated in Study Group.