Feasibility study of coherent 800Gb/s for 10km & 40km

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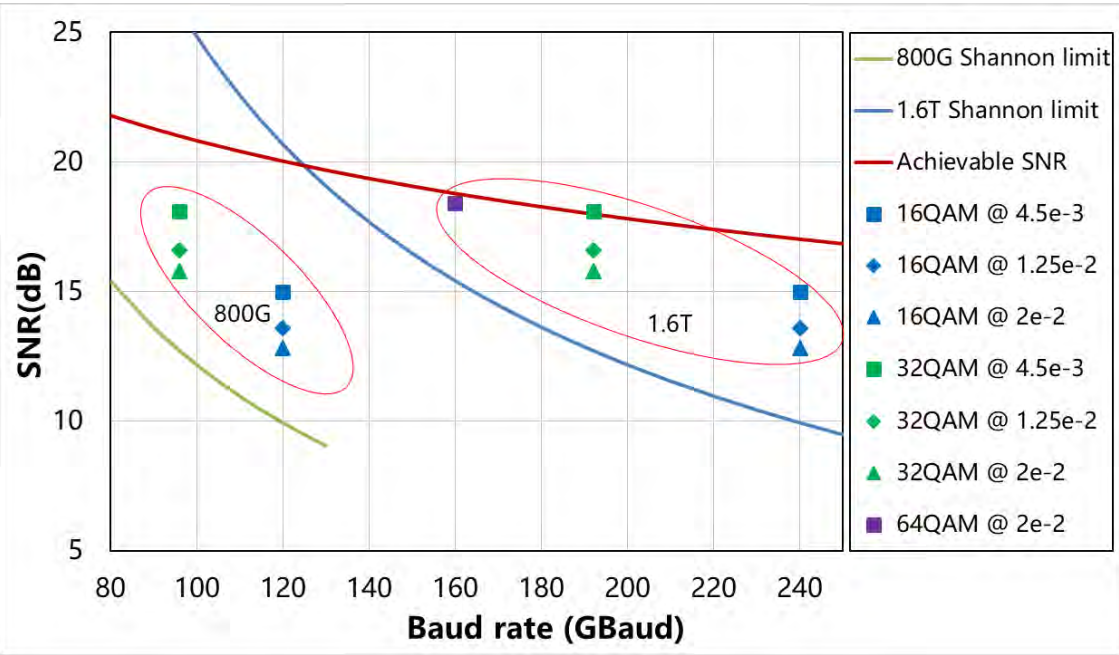
Background

- In objectives_b400g_210826 [1], the following objectives of 800GbE rate were adopted.
  - Define a physical layer specification that supports 800 Gb/s operation:
    - over a single SMF in each direction with lengths up to at least 10 km
    - over a single SMF in each direction with lengths up to at least 40 km
- Some OTT service provider showed strong interests in 800Gb/s coherent solution for DCI networks and would like to see more options [2].
- This contribution provides some theoretical analysis and experimental results of 800Gb/s over 10/40km SMF based on single-carrier coherent technology.

[1] https://www.ieee802.org/3/B400G/proj_doc/objectives_b400g_210826.pdf
[2] http://www.ipec-std.org/data-download/IPEC Contribution Jianqiang Li Kuaishou V1.1.pdf

Capacity analysis



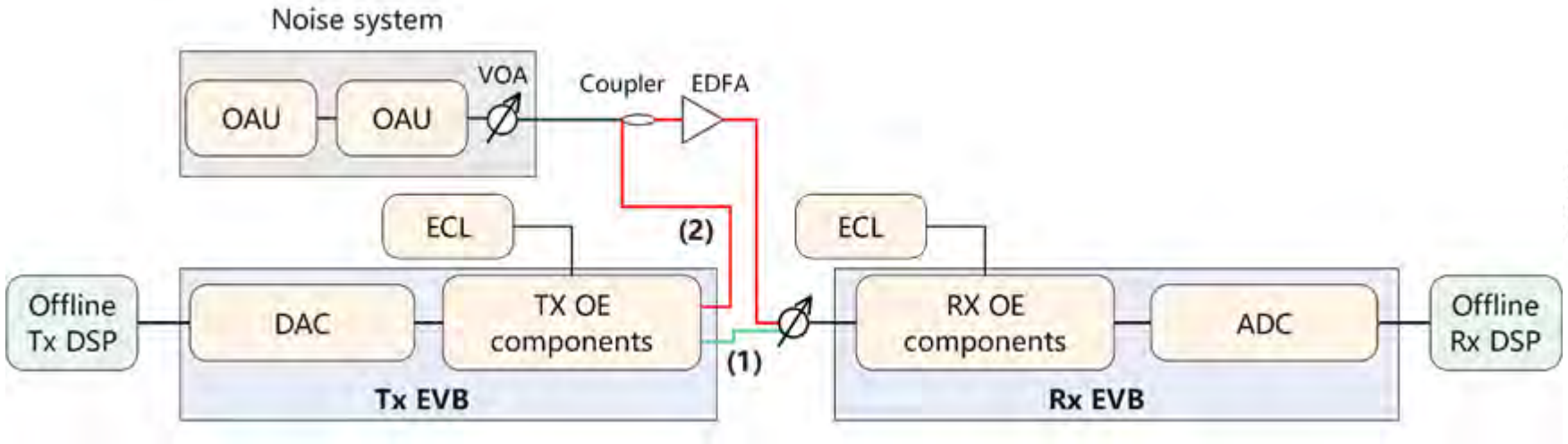
- The minimum required SNRs on green and blue curves were calculated using Shannon's capacity theorem at given data rate and bandwidth.
- The red curve shows the achievable SNR extrapolated from experimental tests.
- Potential solutions lie between green (blue) and red curves for 800Gb/s (1.6Tb/s).
- Candidates for 800Gb/s
  - 96GBaud PDM-32QAM
  - 120GBaud PDM-16QAM
- Candidates for 1.6Tb/s
  - 192GBaud PDM-32QAM
  - 240GBaud PDM-16QAM

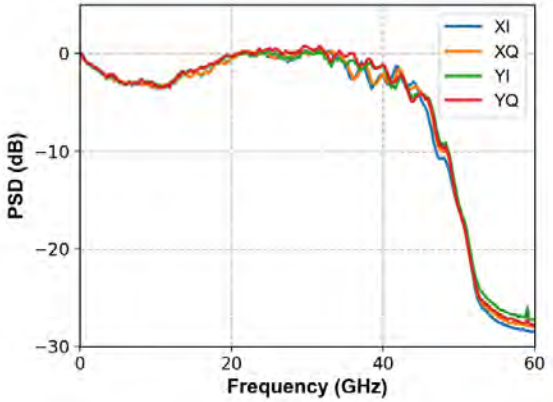
Comparison of two candidates for 800 Gb/s

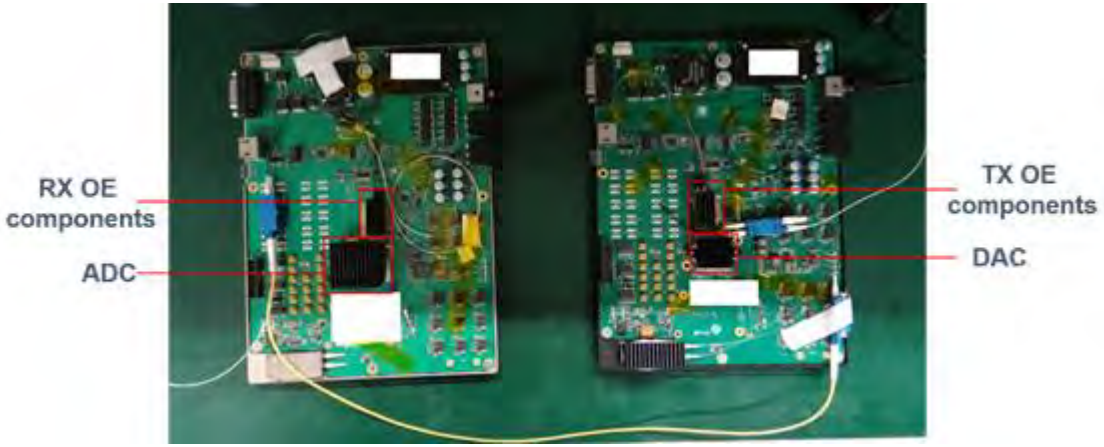
Scheme	Pros	Cons
96GB PDM-32QAM	• Lower sampling rate & power consumption • Higher spectral efficiency • Mature components	• Tighter system margin (BER floor, sensitivity and ROSNR)
120GB PDM-16QAM	• Better system performance (BER floor, sensitivity and ROSNR)	• Higher power consumption • Lower spectral efficiency • Components not ready

- The performance of 96GBaud PDM-32QAM has been experimentally investigated using commercialized optoelectronic components.
- 120GBaud PDM-16QAM will be studied in the near future.

Experimental setup

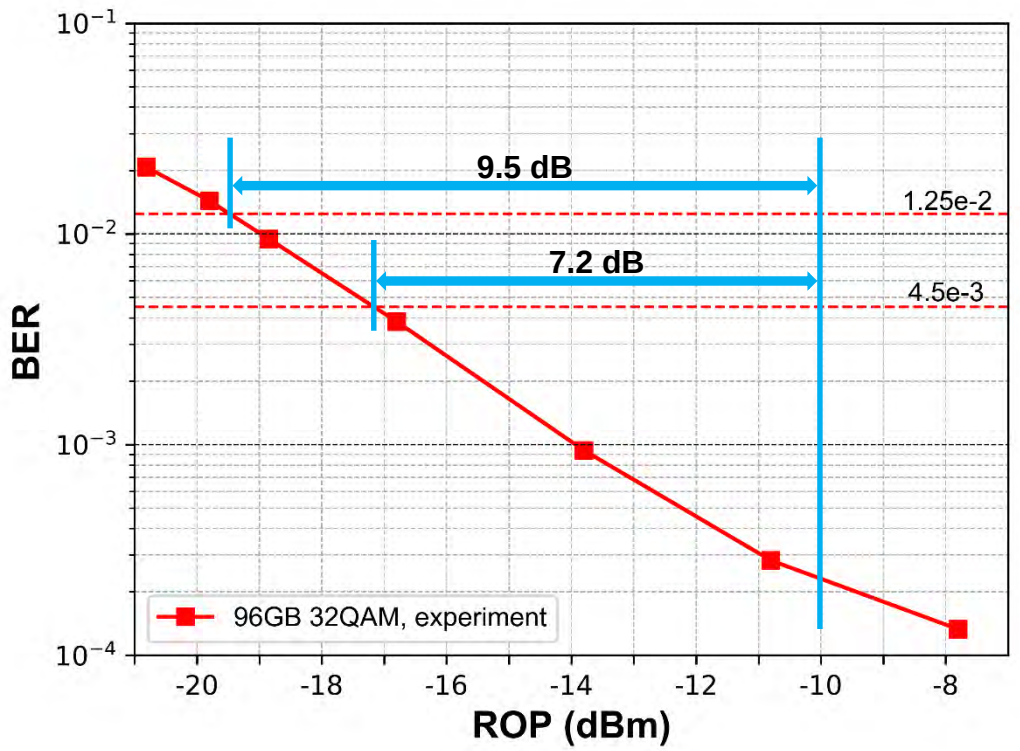






- Two tests were carried out: sensitivity and OSNR.
- Precise calibration of optoelectronic components.
- Fine compensation of components' imperfections.

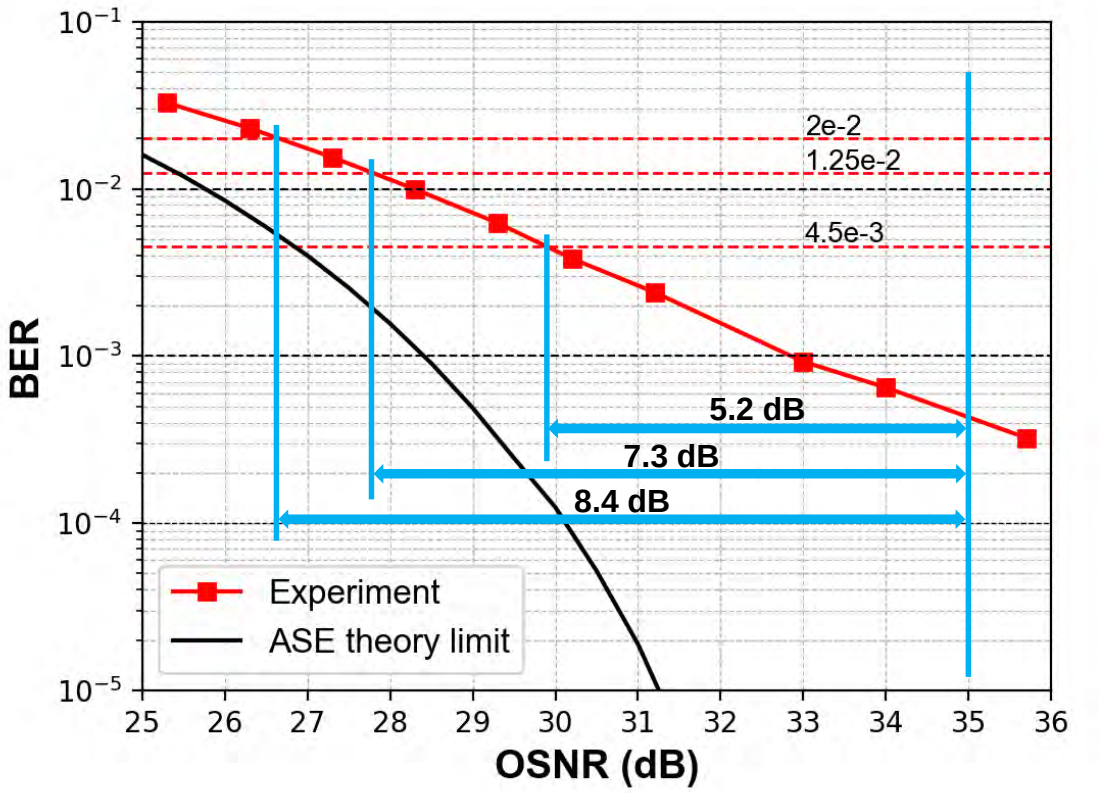
Power budget analysis



- TX output power is assumed to be not less than -10 dBm.
- The BER floor is around 1e-4 which should be sufficient for long-term operation of multiple FEC schemes.
- With 4.5e-3 FEC, 7.2 dB power budget is achieved which may likely close the 10 km link (6 dB link loss + 1.2 dB extra margin).
- With CFEC (1.25e-2), the sensitivity and link budget can be furthered improved by 2.3dB.
- Performance can be further improved by optimizing the constellation [1].

[1] Xiang Zhou, et al., JLT, Vol. 38, No.2, 2020, page 475-484.

OSNR budget analysis



- Following the OSNR link budget methodology in lyubomirsky_3cn_01a_1118 [1] and assuming only Tx EDFA, the system OSNR can be well above 35dB.
- The ROSNR for 3 FEC schemes are all below 30dB (29.8dB@4.5e-3, 27.7@1.25e-2, 26.6@2e-2) with associated OSNR margin shown in the figure.
- The gap between the theoretical limit and measured result indicates potential space for further improvement.

[1] https://www.ieee802.org/3/cn/public/18_11/lyubomirsky_3cn_01a_1118.pdf

Summary

- According to the capacity analysis, both 96GBaud PDM-32QAM and 120GBaud PDM-16QAM are potential candidates for 800GbE.
- Based on our experimental results, 96GBaud PDM-32QAM seems feasible for 800GbE over 10km even with 4.5e-3 FEC thanks to the fine calibration and compensation of components' imperfections.
- With optical amplifier on the Tx side, 96GBaud PDM-32QAM might be able to support 40km transmission as well.
- With this contribution we would like to stimulate more discussion on various 800Gb/s coherent solutions which are also interested in by our customers.

THANK YOU