Additional optical specifications for 800GBASE-LR1 PMD

Kishore Kota – Marvell

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Agenda

- TQM based TX and RX Specifications

Current baseline for 800GBASE-LR1

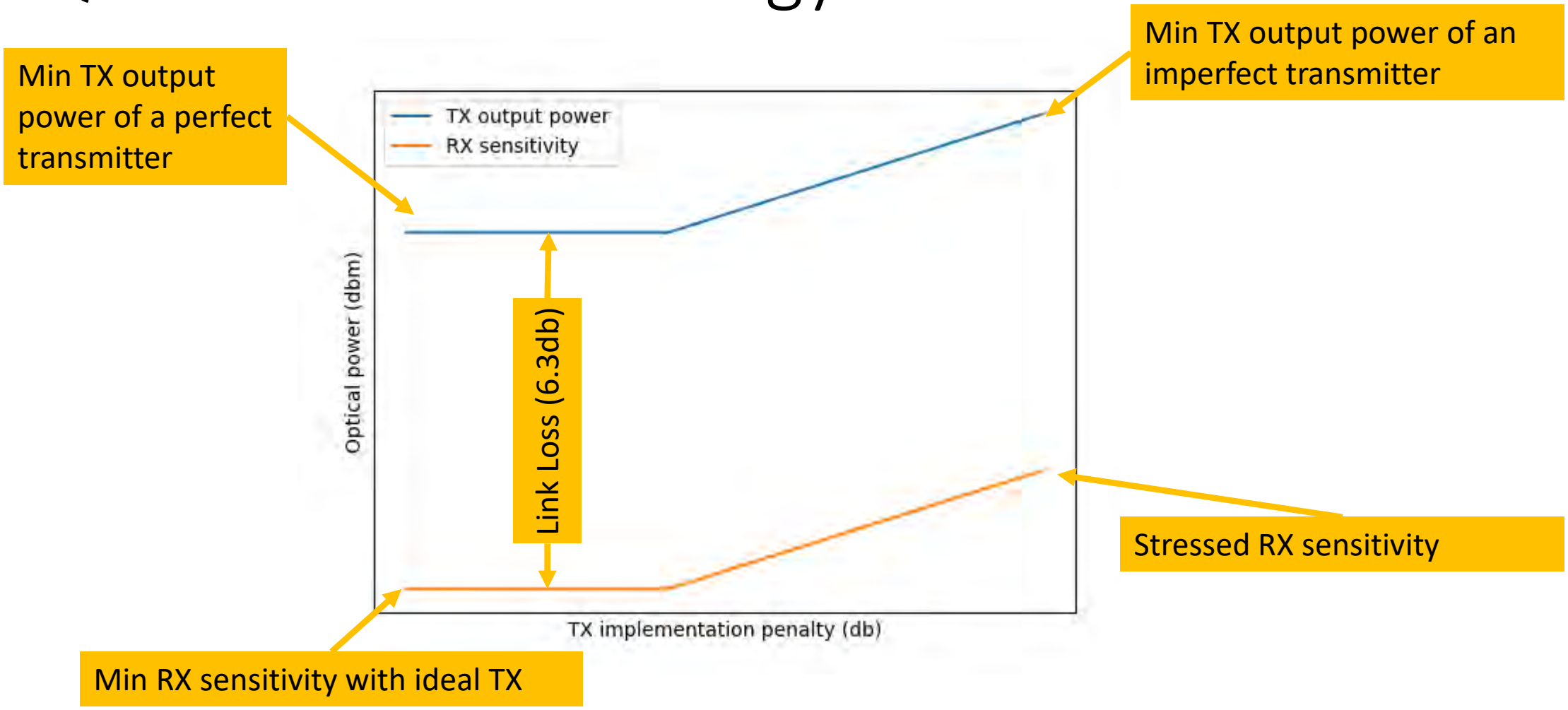
Description	Value	Unit
Transmitter Specifications		
Average channel output power (min)	TBD	dBm
I-Q amplitude imbalance (mean)	1	dB
Power difference between X and Y polarizations (max)	1.5	dB
Transmit Quality Metric	TBD	TBD
Receiver Specifcations		
Average receive power (min)	TBD	dBm

- Coherent specifications to date have been targeted at DWDM applications and the same methodology has been carried over to Clause 185
  - However, 800GBASE-LR1 is a point-to-point technology and does not have the same constraints as DWDM.
  - There is significant opportunity for a different specification style which is borrowed from IMDD which can simplify at scale manufacture of coherent modules
- Problem 1: Specification of a min TX power and RX sensitivity which is independent of TQM results in an overspecification and takes SNR margin from the module manufacturers
- Problem 2: I-Q imbalance of 1dB is very tight and requires calibration to maintain it over life and voltage and temperature changes

Two keys to the alternative methodology

- TX and RX power specifications which are a function of TQM
  - TQM represents the sensitivity impact (in dB) of a given transmitter
  - Similar to the SECQ/TECQ/TDECQ methodology, the TX and RX powers and sensitivities should be tied to TQM
  - This ensures module manufacturers have the flexibility to make the necessary design tradeoffs to improve the ability to scale the manufacture of coherent modules
- Specify the minimum per-lane TX power instead of minimum total TX power
  - Coherent transmitters have 4 lanes which will not match because of manufacturing variability
  - A tight I-Q imbalance specification forces reduction in power of other lanes to match the worst lane
  - In a point-to-point link this represents a net loss in link budget

TQM based Methodology



RX Specs using alternate methodology

Description	800GBASE-LR1	Unit
Receiver sensitivity (min)		
for TXQ<1.4dB	-18	dBm
for 1.4dB<TXQ<3.4dB	-19.4 + TXQ	dBm
Stressed receiver sensitivity (min)	-16	dBm

Minimum receive power per lane is defined based on the transmitter Q-penalty metric. Transmitter Q-penalty is the penalty (in dB) incurred by a transmitter at a reference receiver (TBD)

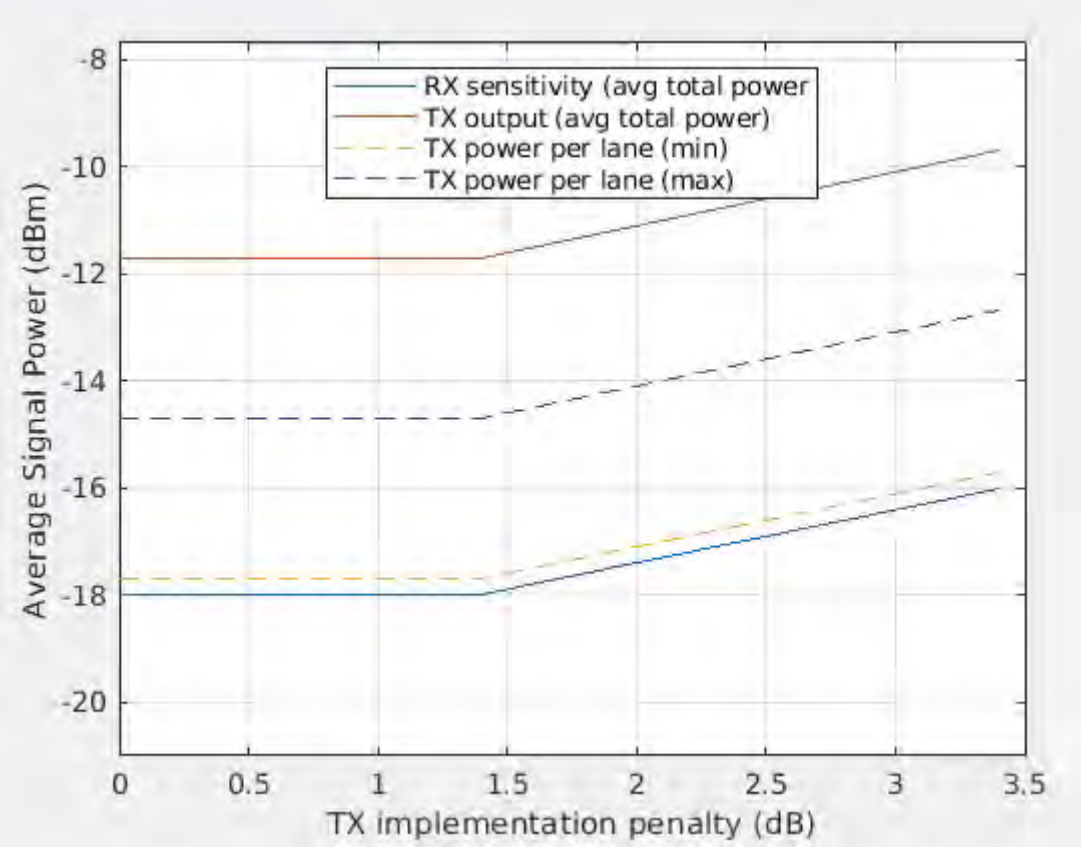
Transmit Characteristics (contd)

Description	800GBASE-LR1	Unit
Average launch power, each lane (max)	-12.7	dBm
Average launch power, each lane (min) for TXQ<1.4dB for 1.4dB<TXQ<3.4dB	 -17.7 -19.1 + TXQ	 dBm dBm
Difference in average launch power between lanes (max)	3	dB
Transmit Q-penalty (max)	3.4	dB

Defining minimum transmit optical power per lane (XI/XQ/YI/YQ). This power can be calculated by measuring the total power and measuring lane power imbalances using an OMA or a receiver

Following IMDD/PAM4 methodology. Defining a TXQ metric for a transmitter. Minimum transmit power of a lane is a function of the TXQ for that lane

TX and RX optical signal powers



- Example 1: TX with perfect equalization and bandwidth (TXQ=0dB)
  - TX power (min): -11.7dBm
  - RX power (min): -18dBm
- Example 2: TX with imperfect equalization/bandwidth (TXQ=3.4dB)
  - TX power (min): -9.7dBm
  - RX power (min): -16dBm
- Example 3: TX with imperfect equalization/bandwidth (TXQ=3.4dB) and 3dB X-Y power imbalance
  - TX power (min): -7.9dBm
  - RX power (min): -14.2dBm

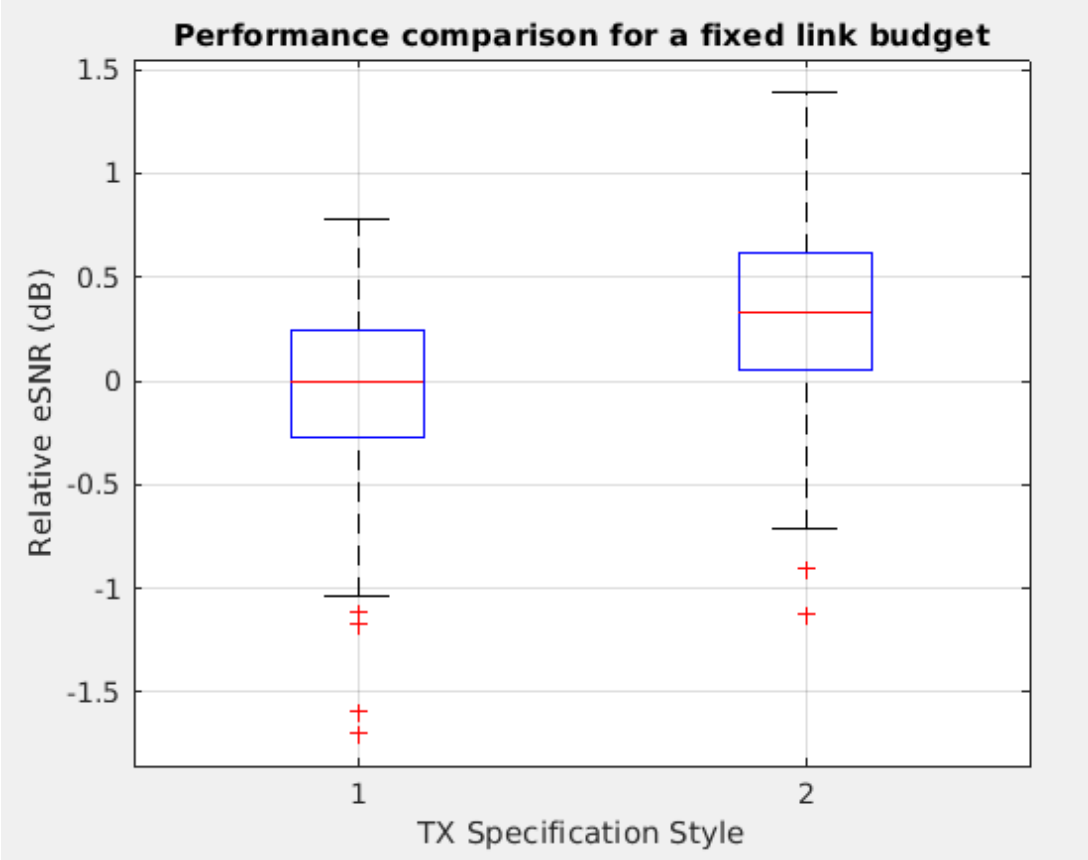
Analysis of TX power & imbalance specification styles

- Proposal from oif2023.506.04
  - Ptx (min): -9dBm
  - IQ-imbalance (max): 1dB
  - XY=Imbalance (max): 1.5dB
- Example of per-lane power without calibration which can meet this spec
  - Mean: -14.5dBm, sigma: 0.16dB
  - Per lane 3sigma range: [-14,-15]dBm
- Other options with calibration can accept a higher sigma and reduce the gain of the channel with higher power to meet the I-Q imbalance and PDL specs
- Higher sigma is also acceptable with a different yield target

- This proposal
  - Ptx_lane(min): -16dBm
  - Lane mismatch (max): 3dB
- Examples of per-lane power without calibration which can meet this spec
  - Mean: -14.5dBm, sigma: 0.5dB
  - Per lane 3sigma range: [-13,-16]dBm
- Other examples could have systematic mismatches between polarizations, but with a tighter sigma
- There is a clear manufacturing cost benefit from this approach to specification

Monte-Carlo Simulations

- Simulation to compare impact of the two TX specification styles:
  - Case 1:
    - Average TX power set to -9dBm
    - I/Q imbalance limited to 1dB,
    - X/Y imbalance limited to 1.5dB
  - Case 2:
    - Min TX lane set to -9dBm-6dB = -15dBm
    - Power mismatch between lanes limited to 3dB
- RX receives the TX signal after a insertion loss matching the desired link budget
- All the other channel, TX and RX parameters are varied to mimic variations expected to see in the system
- eSNR is computed from the measured BER in each simulation



Summary

- Proposing TQM based methodology for 800GBASE-LR1
- A point-to-point link such 800GBASE-LR1 can benefit from such a change

Thank you!