Updated Considerations on a 4x112Gb/s PAM4 Configuration for the 2km SMF PMD

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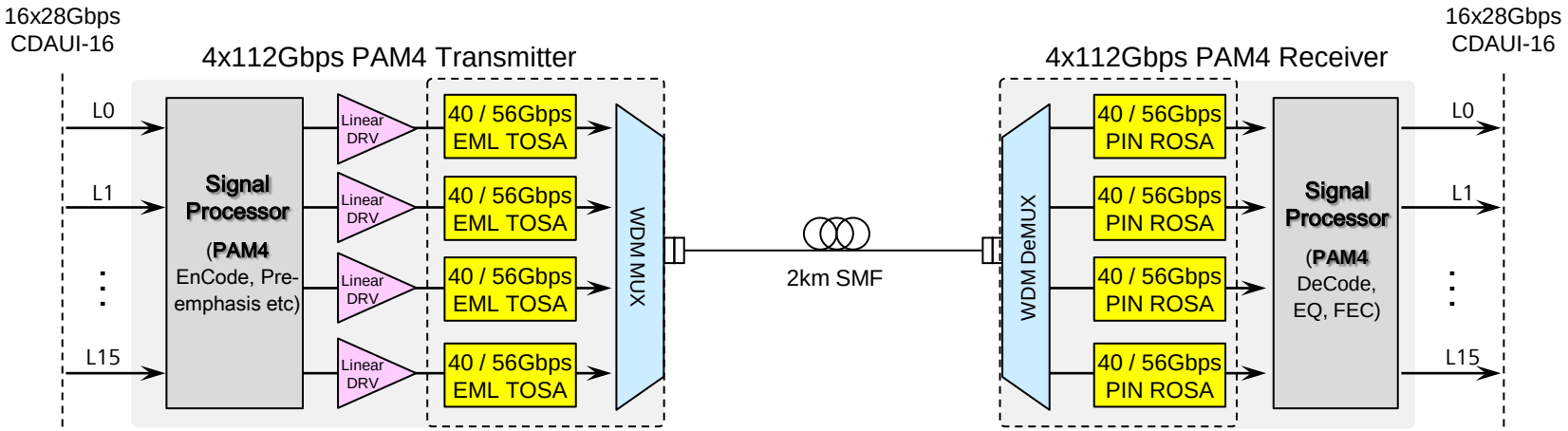
Introduction

- Many people have expressed their preference for 100G serial solutions
- Over past BS and 400GE Study Group meetings lot of material has been presented (considerations, simulations and test results)
- In this presentation a 4x112 Gb/s PAM4 configuration is further considered
- Currently available test results used for analysis of potential loss budget
- Open discussion and invitation

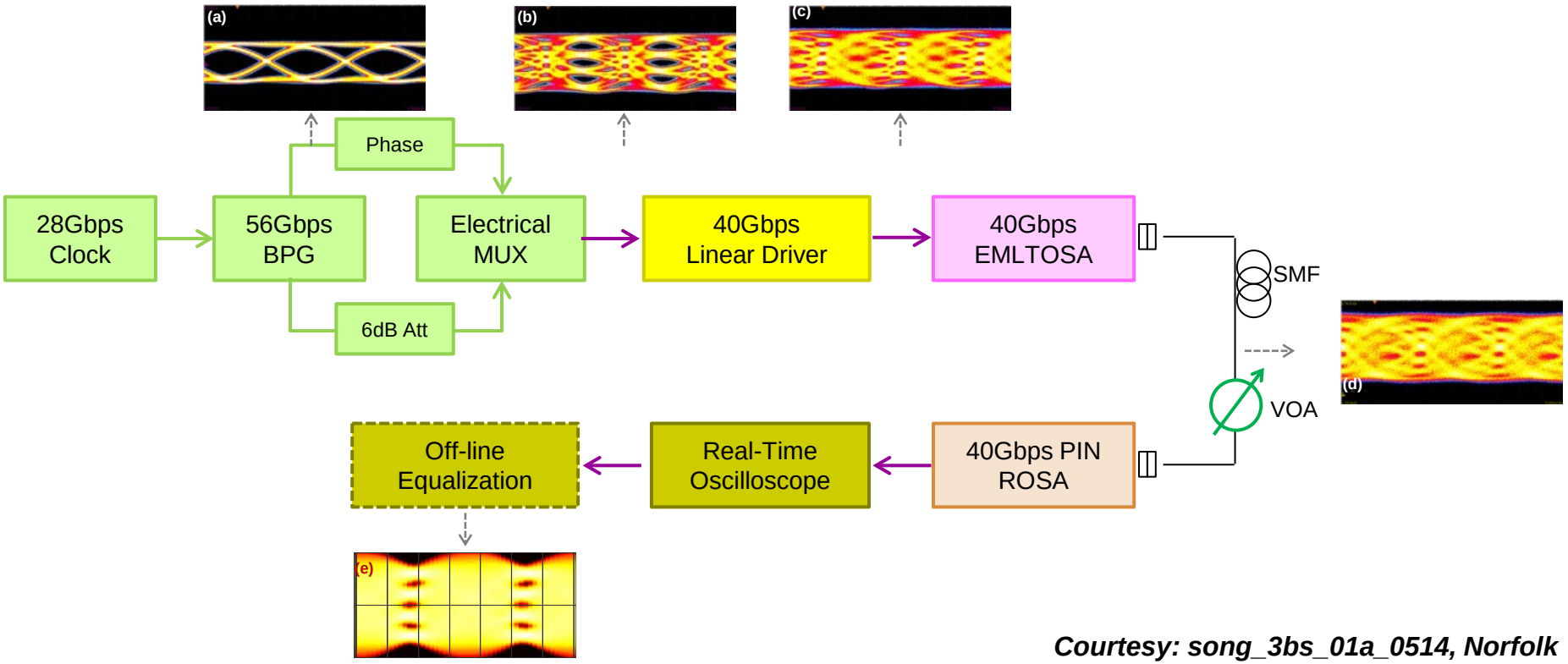
Configuration of 4x112Gbps PAM4



Courtesy: song_3bs_01a_0514, Norfolk

- A 4x112Gbps PAM4 configuration with the 100G-LR4 LAN-WDM wavelengths is a potential solution for the 400GE 2km PMD .
- We assume a CDAUI-16 electrical interface.
- High-bandwidth optical devices will be considered to enable 112Gbps PAM4 modulation, such as the used EML TOSA and PIN ROSA with BW around 40G.
- PAM4 coding/decoding, equalization and FEC is foreseen.

Experimental Demonstration of 4x112Gbps PAM4 for 2km



Courtesy: song_3bs_01a_0514, Norfolk

Transmitter:

TOSA: 40Gbps EML, 32GHz BW, 6dB ER

Driver: 40Gbps linear driver, ~32GHz BW

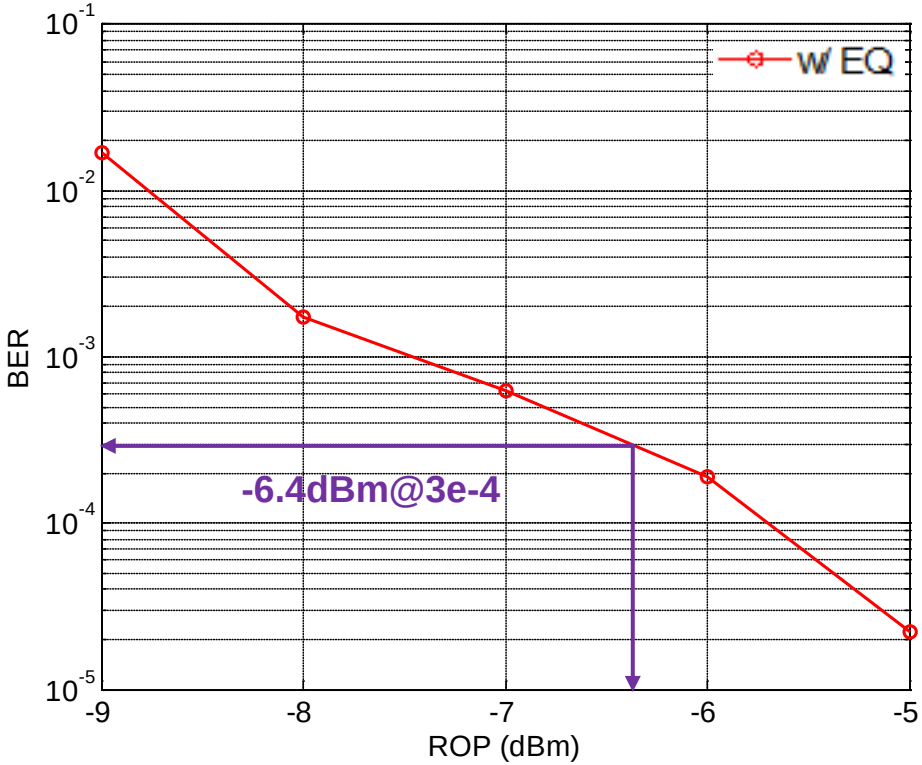
Receiver:

ROSA: 40Gbps PIN-PD, linear TIA

Real-time scope: BW 33GHz, sampling rate 80GS/s

Offline data processing

Experimental Demonstration of 4x112Gbps PAM4 for 2km



- Updated 112Gbps PAM4 experiments have been carried out, which were based upon commercial 40Gbps devices.
- Compared with experiments reported in song_3bs_01a_0514, electrical cables and connectors were changed and noise of ADC inside the real-time scope was improved.
- An ROP (average) of -6.4dBm @ 3e-4 (after demux) has been achieved with equalization.

Analysis of latest test results (rough analysis)

- Transmitter power levels:
  - Average power **after mux** in test: +1dBm
  - Translates to: OMA (11-00) = +4 dBm (ideal conditions)
  - Translates to: **OMA (01-00) = -0.8 dBm** (ideal conditions)
- Receiver power levels:
  - Average power **after demux** in test, assuming KP4 FEC (@3e-4): **-6.4 dBm**
  - Assuming 1.5 dB demux loss, average power **before demux**: -4.9 dBm
  - Translates to ROP OMA (11-00) = -1.9 dBm (ideal conditions)
  - Translates to **ROP OMA** (01-00) = **-6.7 dBm** (ideal conditions)
- Assuming max TDP = 1 dB for EML transmitter
- Assuming a channel insertion loss specification of 4 dB for 2 km SMF

Possible loss budgets (Black & White analysis)

	HW test	Manufacturing specification 1	Manufacturing specification 2	Unit
Tx OMA (01-00) min Tested	-0.8	–	–	dBm
Tx OMA (01-00) min Specification Value	–	-1	-6	dBm
TDP	1	1	1	dB
Tx OMA (01-00) – TDP min	-1.8	-2	-7	dBm
Channel insertion loss Specification Value	–	4	4	dB
Rx ROP OMA (01-00) with KP4 FEC Specification Value	–	-6	-11	dBm
Rx ROP OMA (01-00) with KP4 FEC Tested	-6.7	-6.9	-12	dBm
Available channel loss	**4.9**	–	–	dB

Open discussion

- Transmitter power levels:
  - How realistic is Minimum OMA (01-00) of -1 dBm for EML transmitters
  - Or do we need to assume -6 dBm as in cole_01a_0614_smf
  - More input needed on realistic min OMA under manufacturing conditions
- Receiver power levels:
  - How much difference would we want to see in ROP levels below specified value
  - Currently KP4 FEC with Rx BER operating point of 3e-4 is assumed
  - What level of higher coding gain would be possible?
  - Without significant increase of clocking speed or power consumption
  - More input needed

Invitation

- Other people from different organisations are invited
  - To provide further testing data
    - Minimum Tx OMA
    - Rx ROP @ 3e-4
    - TDP
  - To provide appropriate values for manufacturing conditions
  - To possibly use FECs with higher (but not too high) coding gain
- In order to establish:
  - A realistic sense that 4x112G PAM4 for 2km SMF is considered feasible within BS timeframe
  - Or alternatively that further technology improvement is needed

Thank you