Technical Feasibility Update on single wavelength 100Gbps PAM4 modulation

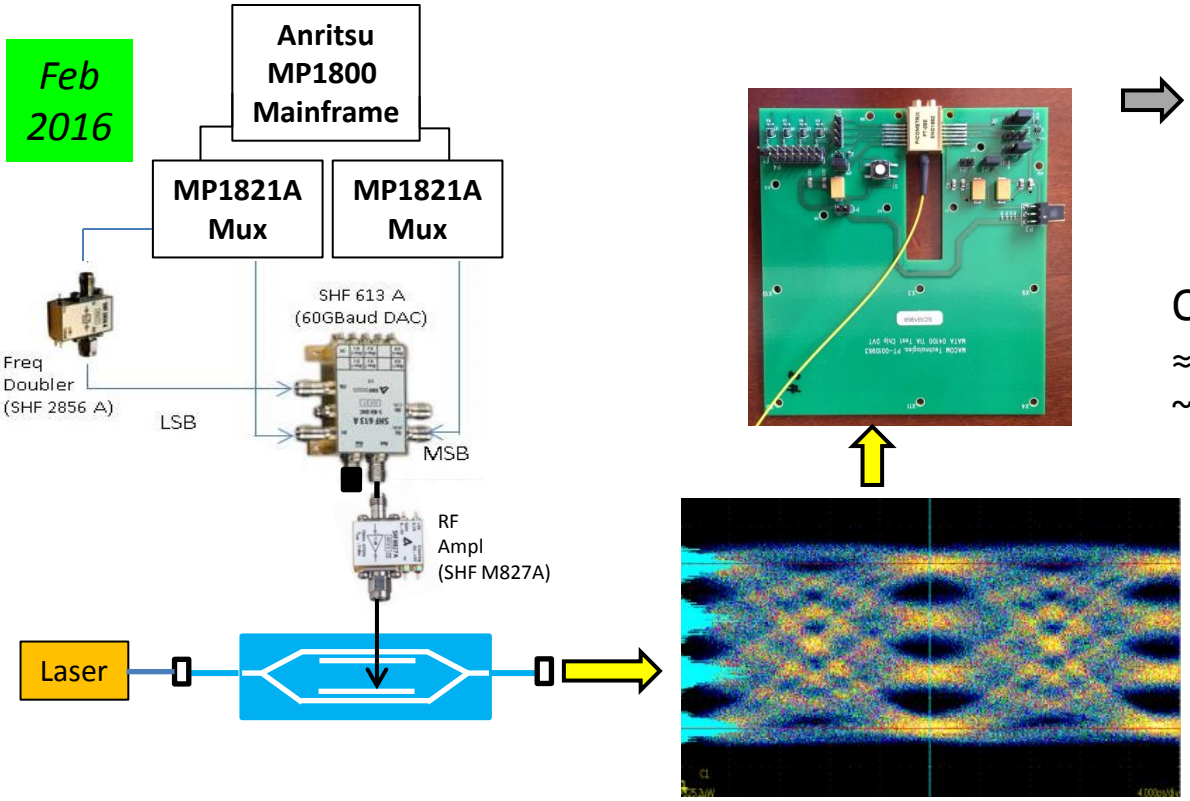
Matt Traverso, Cisco
Marco Mazzini, Cisco
Chris Fludger, Cisco
Atul Gupta, Macom
Tom Palkert, Macom

Past Presentations

- See traverso_3cd_01a_0716
- We were able to capture PRBS20 data & show new results

53GBaud PAM 4 TX/RX : improved set-up

(no change from traverso_3cd_01a_0716)



Agilent DSA-X 96204Q-62GHz (160Gs/s real time)

Optical RX Characteristics:
≈30GHz (3dB) BW
~ 13 pA/√Hz

Transmitter Improvements

- RF Amplifier improves swing yet more distortion
- Improves eye opening ~8dB ER
  - –About 1dB power penalty vs. min 5dB ER

Receiver Improvements

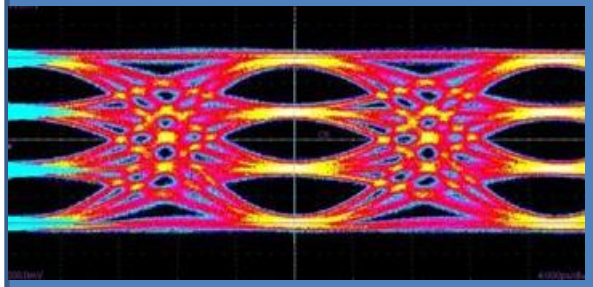
- Macom TIA lower noise than Discovery Semiconductor used in previous setup
- Improved Gain & BW – esp higher AGC output swing

Transmitter optimization

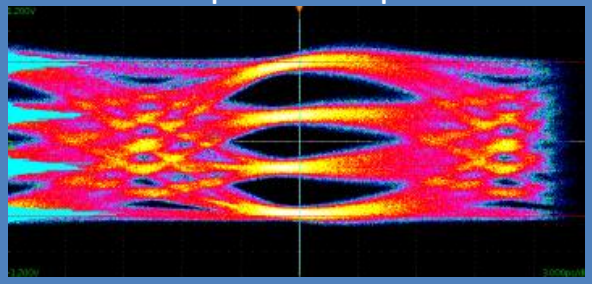
(no change from traverso_3cd_01a_0716)

- DAC settings were optimized (swing, Xpoint, etc)
- Waveforms were capture on sampling scope & via real time scope
- Analysis conducted on real time scope waveforms in Matlab via offline processing

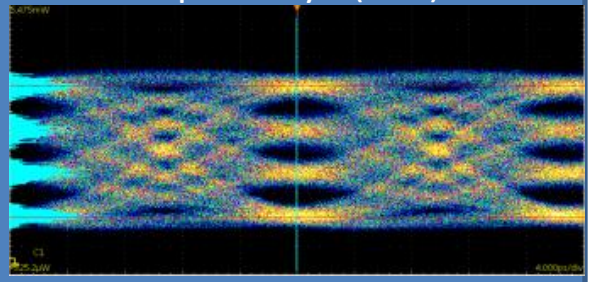
DAC output



Amplifier output

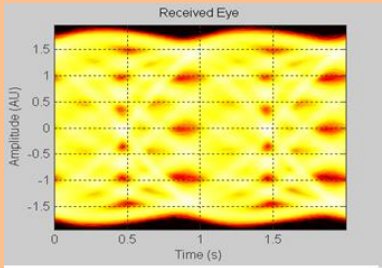


Optical eye (TP2)

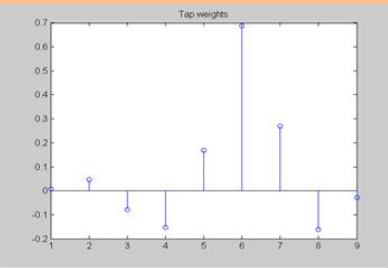


Sampling Scope

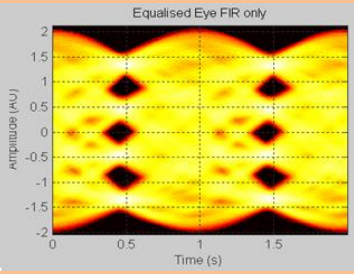
Raw Data from TIA



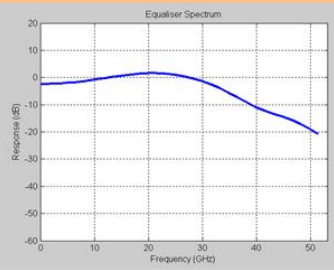
FFE Coeff.



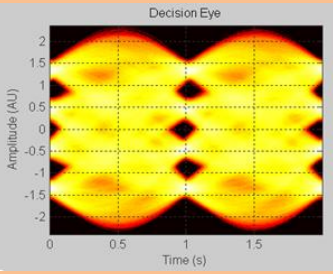
Eye - FIR only Equalized



Eq. spectrum

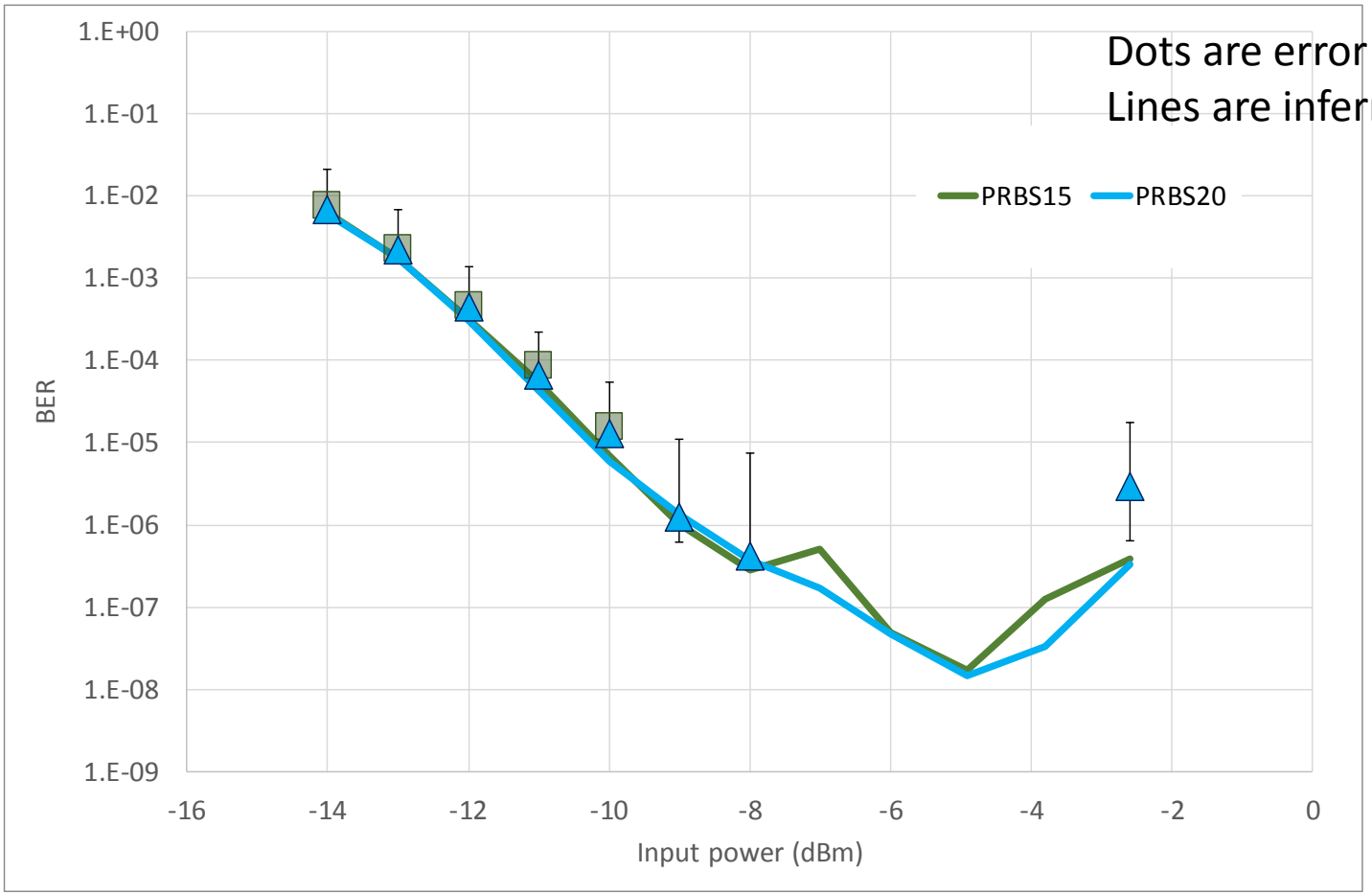


Decision Eye



Captured/Stored Waveforms

PRBS15 and PRBS20

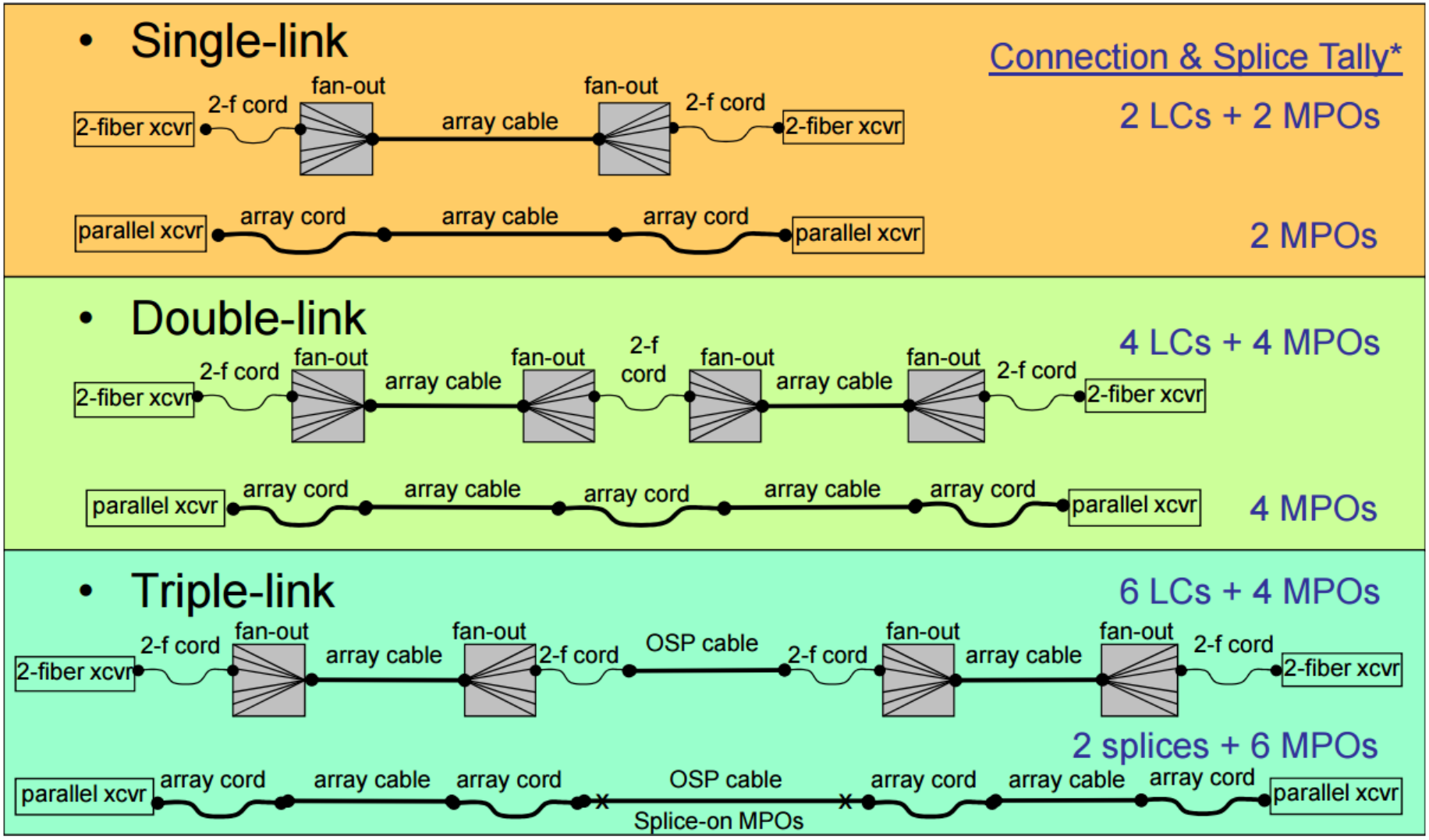


- PRBS20 with 1.2M symbols ; PRBS15 with 160k symbols

LINK CONFIGURATION & MPI PENALTY

Common channel implementations

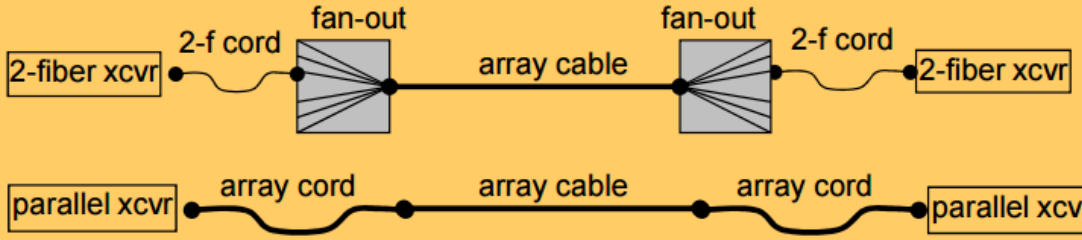
kolesar_3bs_01_0514



*Connections to transceivers (at MDI) are not counted in standard loss budget

Breakout Variation: Single-link

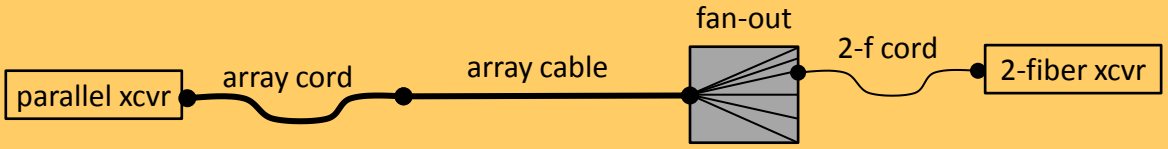
- Single-link



Connection & Splice Tally*

2 LCs + 2 MPOs

2 MPOs



1 LCs + 2 MPOs

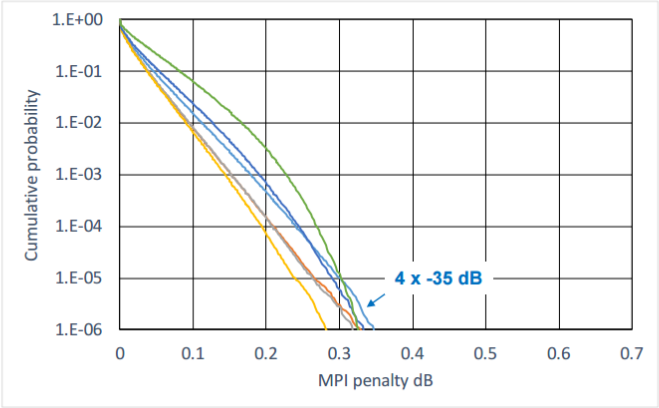
MPI Penalty

- Propose 0.3dB MPI penalty to align with channel corresponding to Double-link configuration
- Need to confirm using methodology like anslow_03_0816 or king_02a_0116_smf.7z – this work to be done

FR4, FR8 0.3 dB penalty

BER 2.4E-4
ER 4.5 dB

-26	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	4.0	-26
-26	-39	-39	-55	-39	-39	-39	-39	-55	-39	-39	4.0	-26
-26	-38	-55	-55	-38	-38	-38	-38	-55	-55	-38	4.0	-26
-26	-35	-55	-55	-55	-35	-35	-55	-55	-55	-35	4.0	-26
-26	-31	-55	-55	-55	-55	-55	-55	-55	-55	-31	4.0	-26
-26	-55	-55	-55	-55	-55	-25	-55	-55	-55	-55	4.0	-26



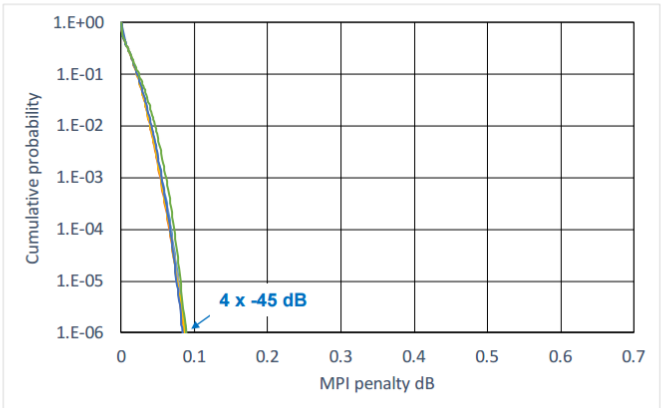
Return

15

DR4, DR4 0.1 dB penalty

BER 2.4E-4
ER 4.5 dB

-26	-49	-49	-49	-49	-49	-49	-49	-49	-49	-49	3.0	-26
-26	-48	-48	-55	-48	-48	-48	-48	-55	-48	-48	3.0	-26
-26	-47	-55	-55	-47	-47	-47	-47	-55	-55	-47	3.0	-26
-26	-45	-55	-55	-55	-45	-45	-55	-55	-55	-45	3.0	-26
-26	-42	-55	-55	-55	-55	-55	-55	-55	-55	-42	3.0	-26
-26	-55	-55	-55	-55	-55	-37	-55	-55	-55	-55	3.0	-26



Return

16

anslow_03_0816_smf

Conclusion

- Longer pattern results show good consistency with shorter pattern
  - Targeting to have even longer pattern testing available by November meeting
- Single link configuration as shown on slide 8 propsed with MPI penalty of 0.3 dB as a strawman – this would add 0.2dB to link budget
- RX sensitivity has margin compared 400GBASE-DR4 specification as of D2.0
- Waveform data can be made available for others to analyze & assist in identifying reference equalizer