In Support of Linear Interface: Updated Measurements / Simulations

MACOM

Ryan Latchman

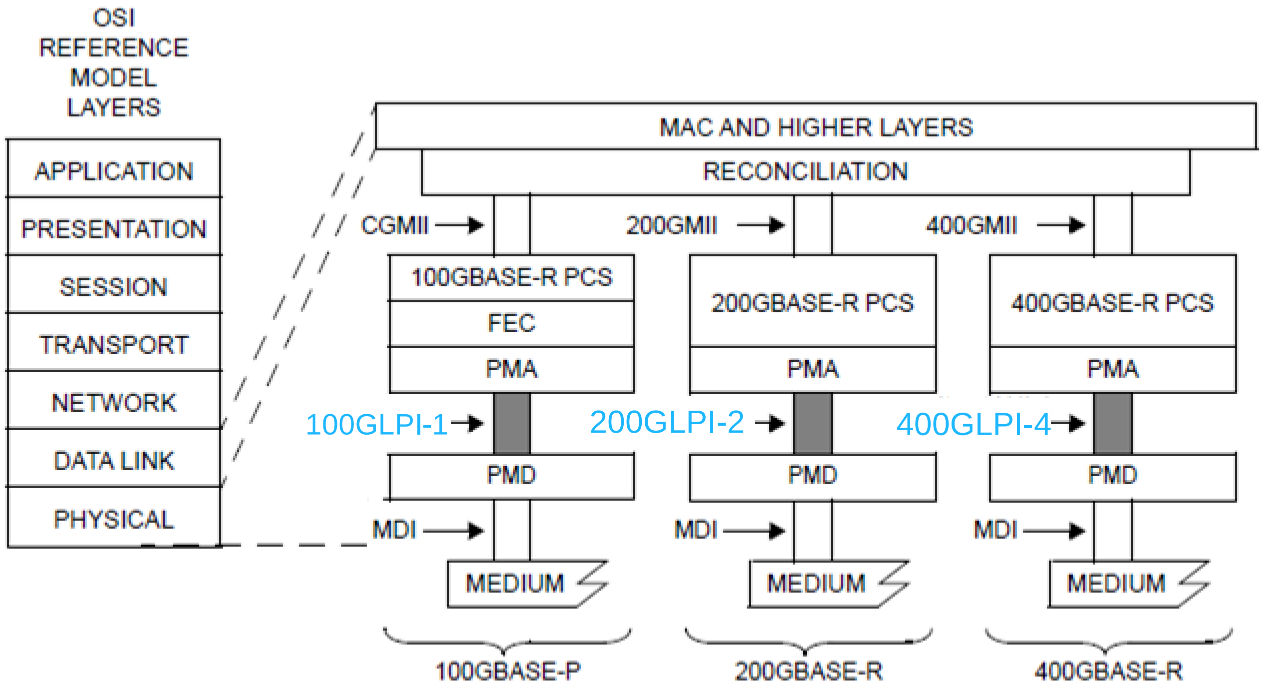
IEEE P802.3db Ad Hoc Teleconference
1 Oct 2020

Agenda

- Introduction
- Rx Path Measured Results
  - Leveraging Electrical TDECQ with Trace Loss
  - Sensitivity results with 10dB Channel
- Tx Path simulations
- Conclusion

LINEAR PHYSICAL INTERFACE (LPI)

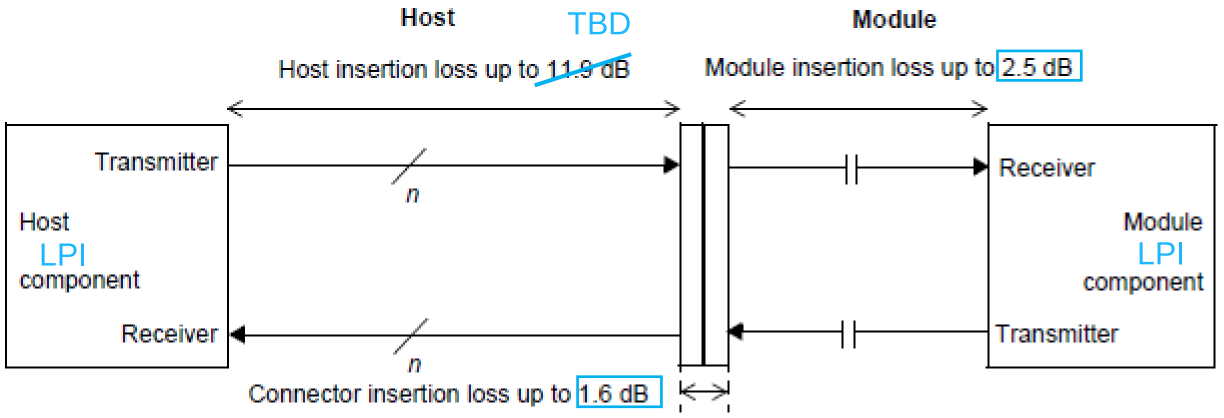
- LINEAR PHYSICAL INTERFACE (LPI) is an **optional PMD service interface for the PMDs in Clause 140, 151, and TBD.** It allows the construction of compact optical transceiver modules for SMF and MMF applications with no clock and data recovery / DSP circuits inside….
- Figure TBD shows the relationship of the LPI interface with other sublayers to the ISO/IEC Open System Interconnection (OSI) reference model …



100GAUI-1 = 100 Gb/s ONE-LANE ATTACHMENT UNIT INTERFACE
200GMII = 200 Gb/s MEDIA INDEPENDENT INTERFACE
400GAUI-4 = 400 Gb/s FOUR-LANE ATTACHMENT UNIT INTERFACE
400GMII = 400 Gb/s MEDIA INDEPENDENT INTERFACE
MAC = MEDIA ACCESS CONTROL
CGMII = 100 Gb/s MEDIA INDEPENDENT INTERFACE
200GAUI-2 = 200 Gb/s TWO-LANE ATTACHMENT UNIT INTERFACE
FEC = FORWARD ERROR CORRECTION
MDI = MEDIUM DEPENDENT INTERFACE
PCS = PHYSICAL CODING SUBLAYER
PMA = PHYSICAL MEDIUM ATTACHMENT
PMD = PHYSICAL MEDIUM DEPENDENT

Channel Insertion Loss Budget & Host LPI

- TBD target= 6.875dB including allowance for BGA and connector footprint vias= 100GBASE-CR
- Host LPI Component much more capable than equalizers used for Optical evaluation



Note—The number of lanes *n* is equal to 1 for 100GAUI-1, 2 for 200GAUI-2, and 4 for 400GAUI-4.

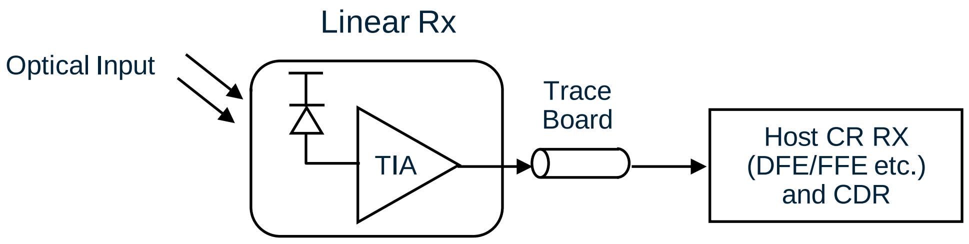
Modified

Figure 120G–2—~~100GAUI-1~~, ~~200GAUI-2~~, and ~~400GAUI-4 C2M~~ insertion loss budget at 26.56 GHz

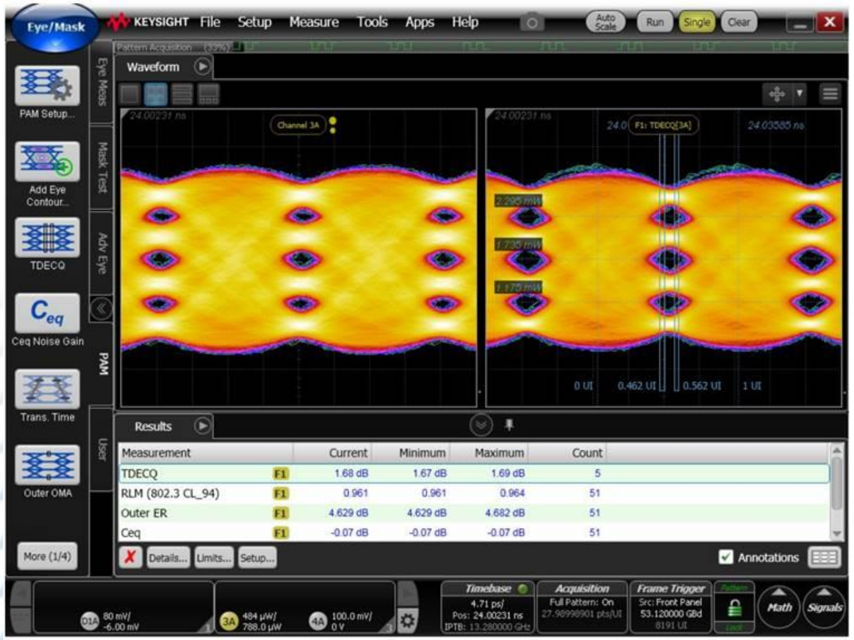
100GLPI-1 200GLPI-2 400GLPI-4

100G Linear Interface Rx Demonstration

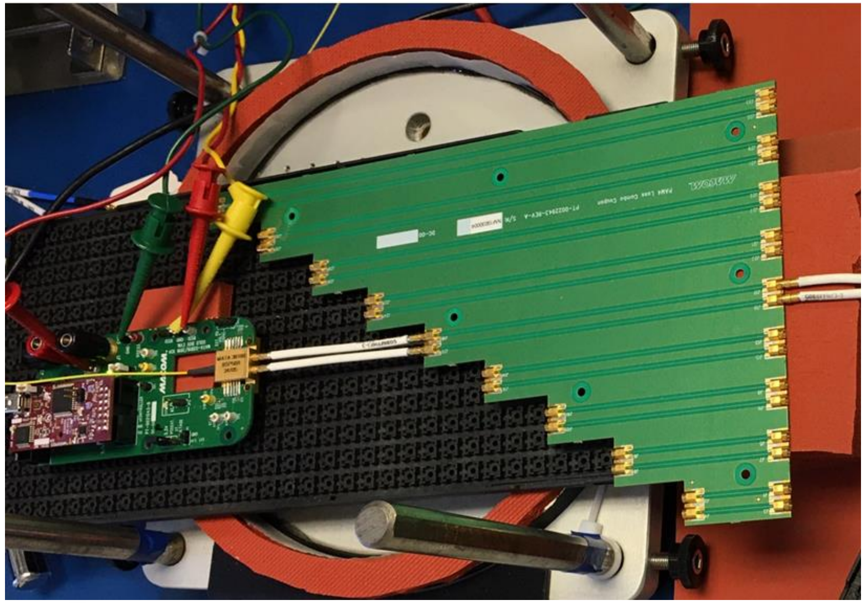
- Optical input: SMF input
- Rx Setup:
  - MACOM PD (BSP56B) and MACOM TIA (MATA-05817B)
  - Trace (emulate host loss)
  - Keysight Scope



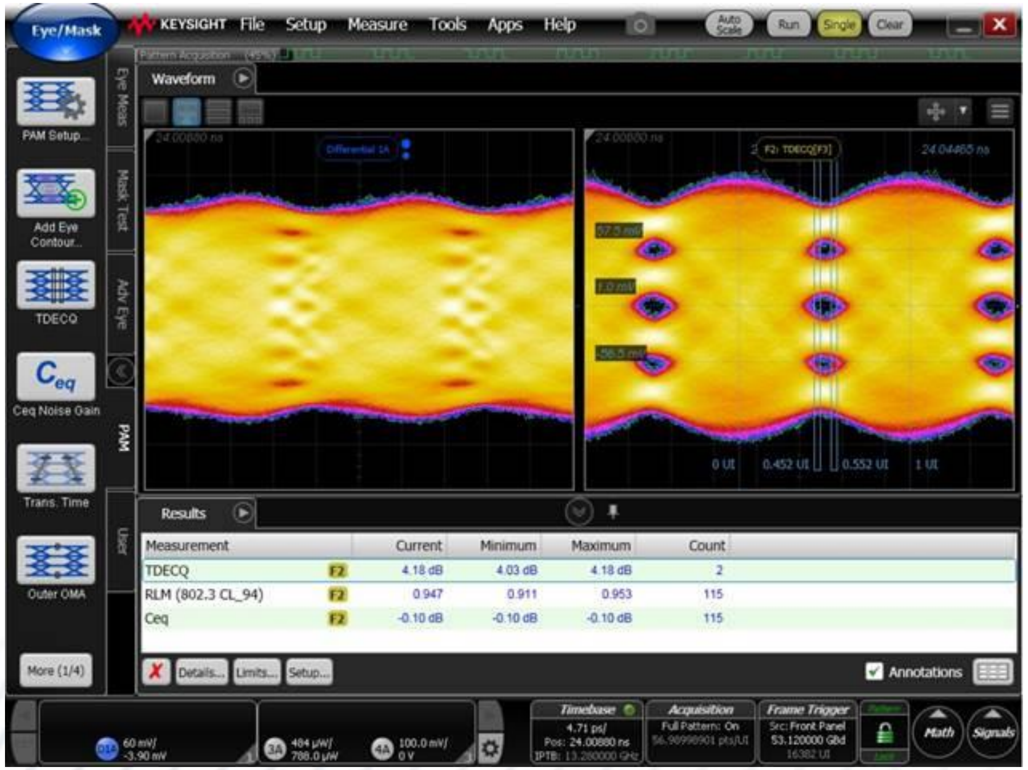
Optical Input



Linear Rx & Trace Board



Optical Source -->MACOM PD/TIA --> Trace Loss Channel (10dB)--> DCA-X

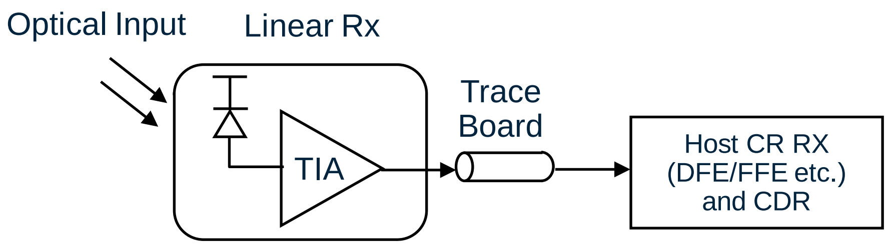


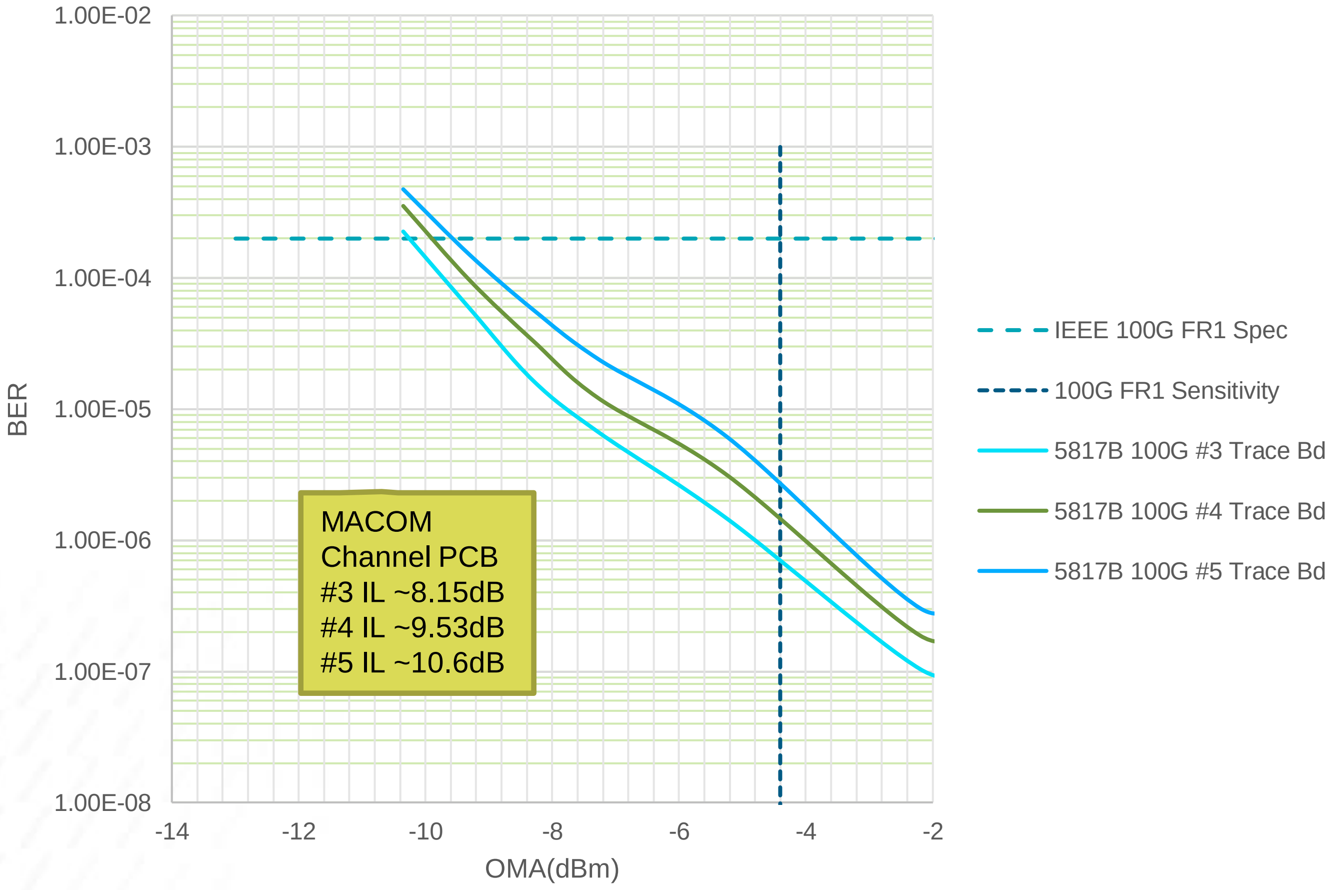
TDECQ FFE Taps=**5**
Electrical TDECQ after trace =**4.18dB**

TDECQ FFE Taps=**9**
Electrical TDECQ after trace = **1.86dB**

100G Optical Source -->MACOM PD/TIA --> Trace Loss Channel--> BER Curve

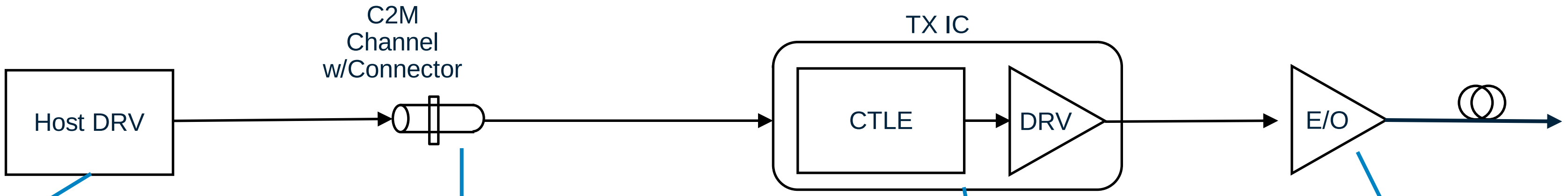
- BER curve measured with 15tap FFE in Rx





VCSEL Simulations in the Tx

Tx Path Simulation Model



Parameter	Symbol	Value	Units
Device package model			
Single-ended device pad capacitance	C_d	1.2×10^{-4}	nF
Single-ended device series inductance	L_s	0.12	nH
Single-ended device bump capacitance	C_b	3×10^{-5}	nF
Transmission line length, Test 1	z_p	12	mm
Transmission line length, Tx Test 2	z_p	31	mm
Transmission line length, Rx Test 2	z_p	29	mm
Transmission line parameter, a_1	a_1	9.909×10^{-4}	$ns^{1/2}/mm$
Transmission line parameter, a_2	a_2	2.772×10^{-4}	ns/mm
Single-ended package capacitance at package-to-board interface	C_p	8.7×10^{-5}	nF
Transmission line characteristic impedance	Z_c	87.5	nF
Transmission line 2 length	z_{p2}	1.8	mm
Transmission line 2 characteristic impedance	Z_{c2}	92.5	Ω

802.3ck channel

mellitz_3ck_01_0518_C2M\9dB

MACOM Tx IC

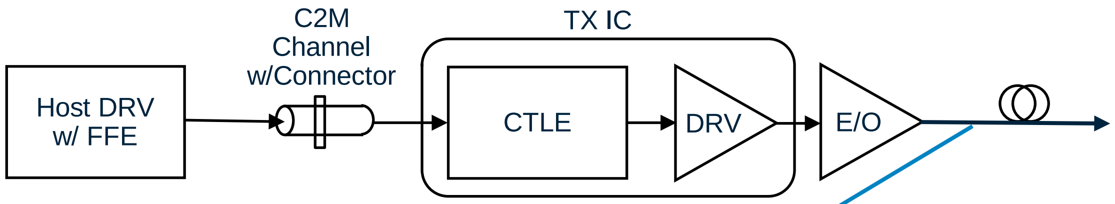
CTLE + VCSEL Driver

VCSEL Model

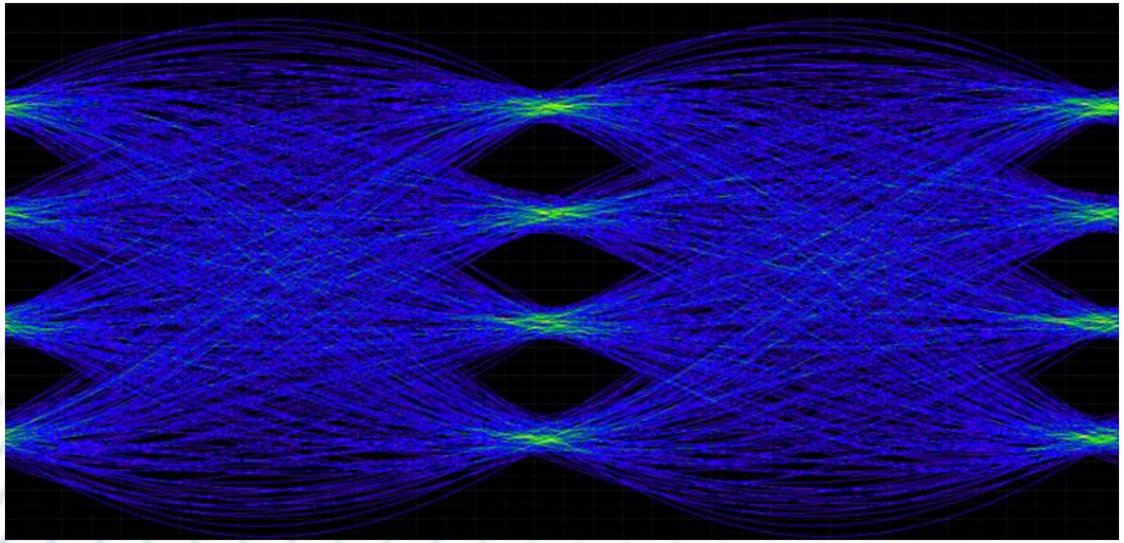
Bandwidth: 26GHz

Simulation Results

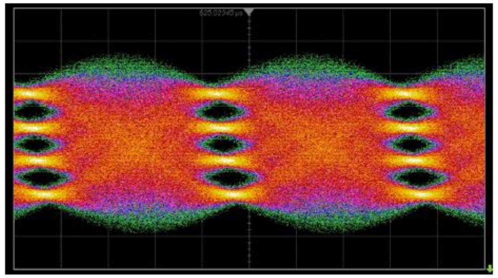
MACOM



Eye Diagram Before Fiber
(with 9 tap FFE)



Eye diagram after 100 m OM4



TDECQ: 3.5 dB

Modulation format	PAM4
Symbol rate	53.125 GBd
Pattern	PRBS15Q
Tx FFE	3-tap T-spaced
SER target for TDECQ	4.8×10^{-4}
DCA optical plug-in bandwidth	34 GHz
DCA SIRC bandwidth	38.3 GHz
DCA BT filter bandwidth	26.6 GHz
DCA FFE	9-tap T-spaced
Temperature	75 °C
Center wavelength	863 nm
RMS spectral width	0.42 nm
Outer ER	3 dB

- 100 m OM4 link: TDECQ within 4.5 dB with a 9-tap Rx FFE

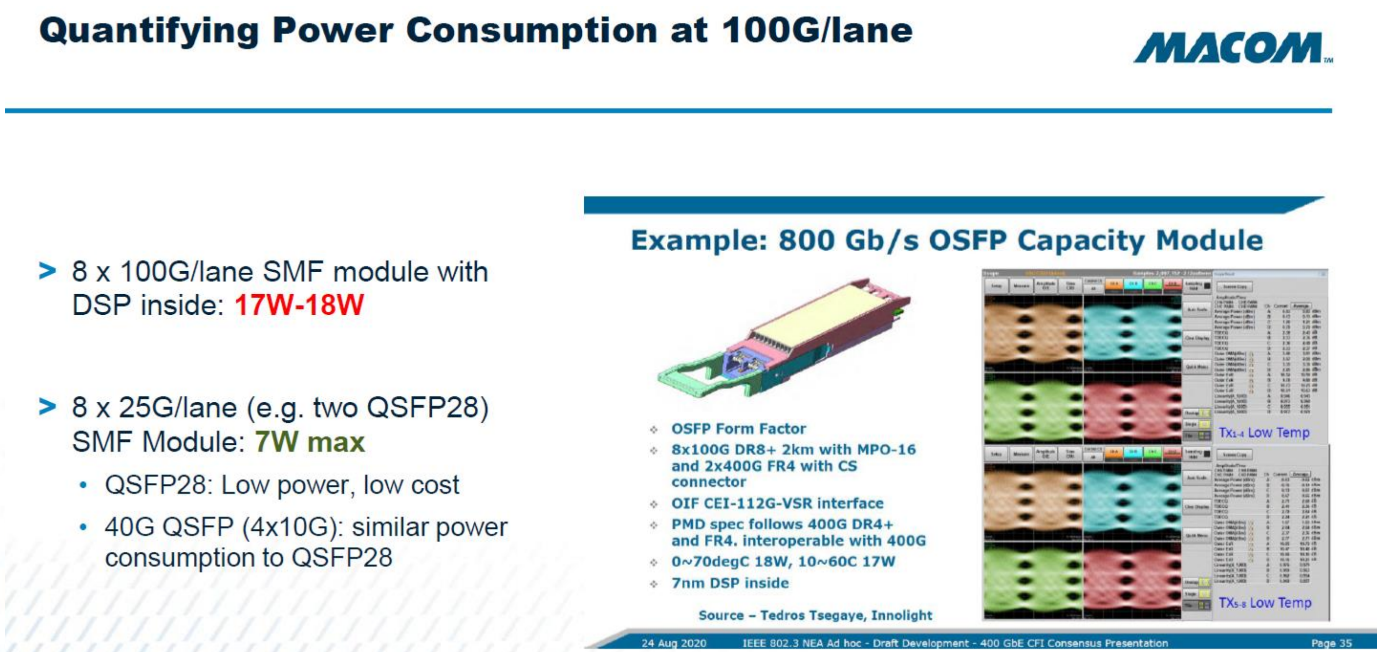
18

Reference: ingham_3db_adhoc_01a_062520

Conclusion

- Linear interface is demonstrated to be feasible via measurements and simulations

- Volume adoption at 100G per λ requires improved economics (relative cost and power)
  - Linear architecture as potential to enable volume ramp and save 10s of MILLIONS watts / year



Reference: dambrosia_nea_01b_200824.pdf