Thoughts on the IL strawman

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(affil: ADI, APL Group, Cisco, CommScope, Marvell, SenTekSe)

Proposed limit line (sedarat)

Decision to Consider

- PROPOSED:

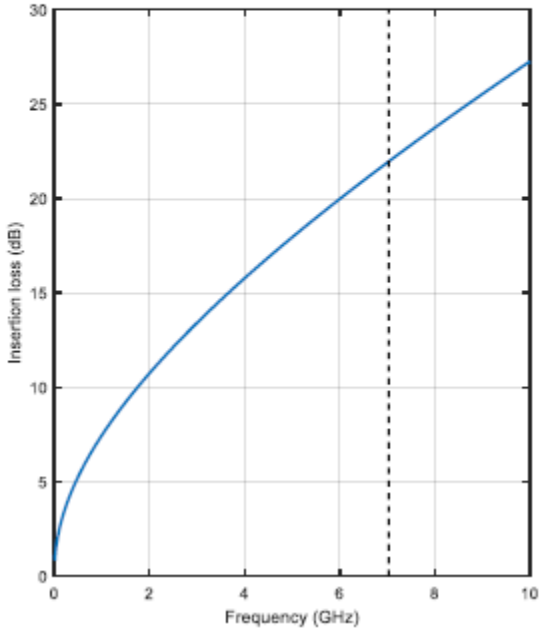
  Move that: 802.3cy consider the following limit-line for insertion loss

$$Insertion\ Loss(f) \leq \frac{6.5}{15}(0.002 \times f + 0.68 \times f^{0.45})$$

Where f is the frequency in MHz,

$1 \leq f \leq F_{max}$, *and* F_{max}=10 GHz

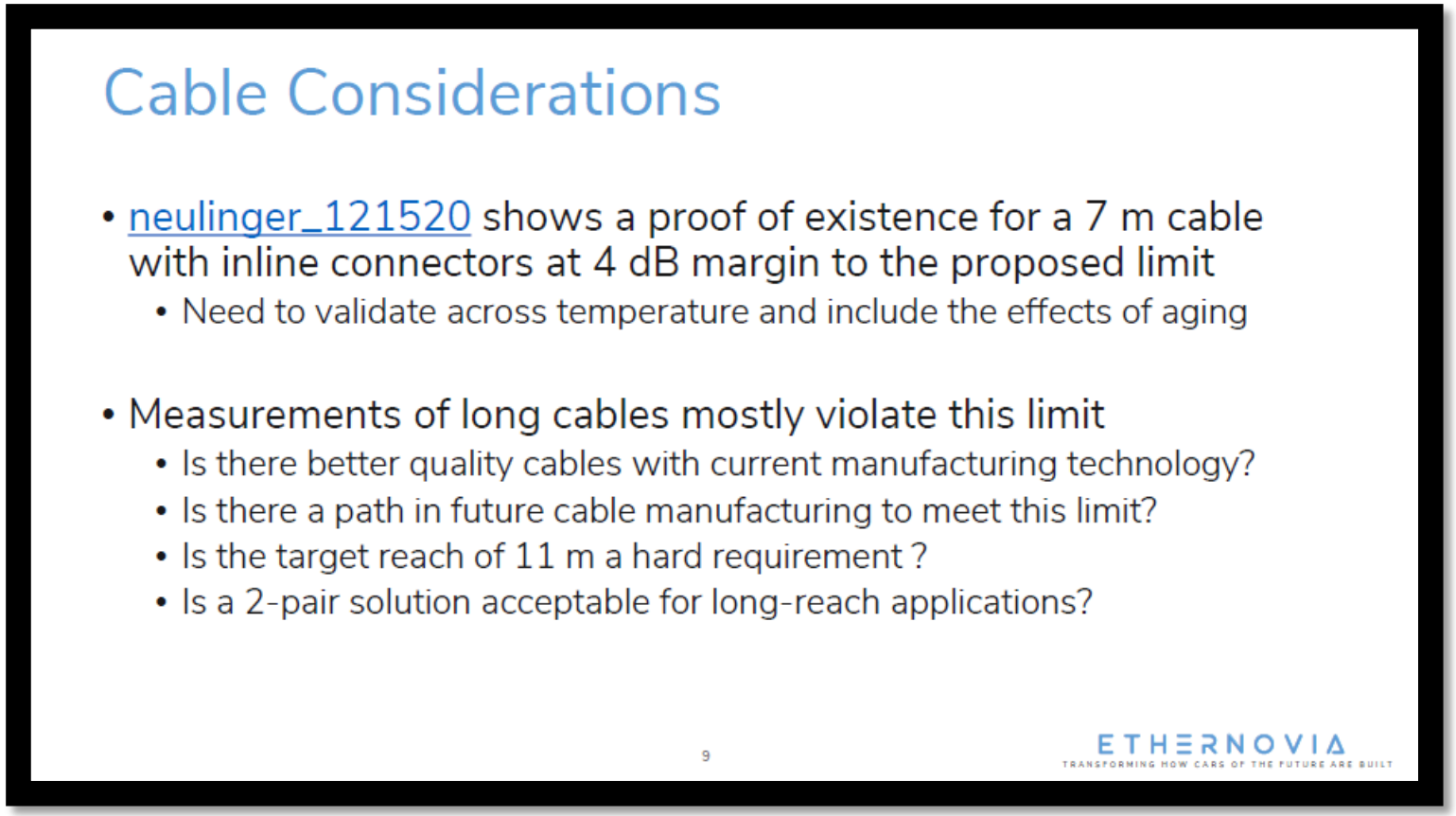
(F_{max} is chosen to be 2.5x the corresponding 802.3ch value)



sedarat_3cy_01_01_12_21.pdf slide 4

Basis: Sedarat_3cy_01_01_05_21

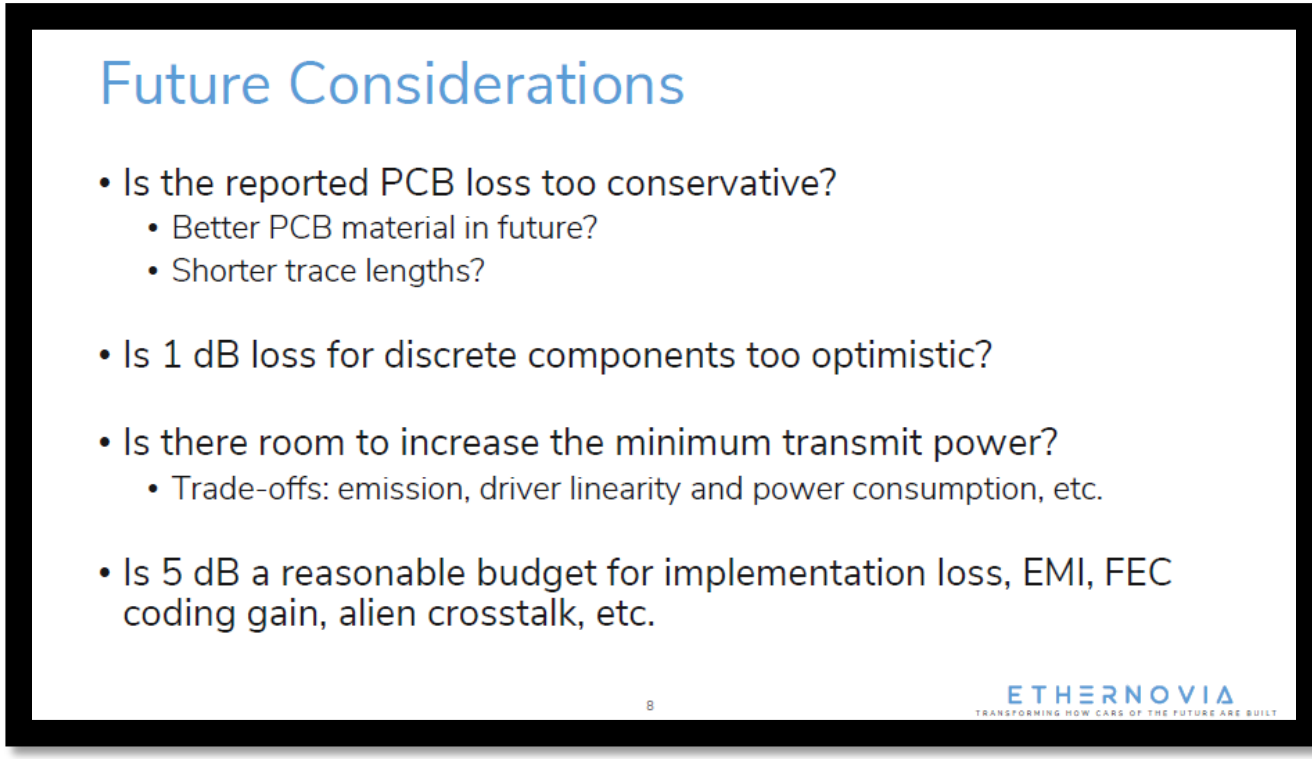
- Acknowledges this is well beyond cables shown to date
- Could likely limit reach of a single cable to as little as 7m
- Requires change of objectives or re-evaluation of CSDs



sedarat_3cy_01_01_05_21.pdf slide 9

Is Sedarat_3cy_01_01_05_21 margin on top of margin?

- Some issues mentioned in slide 8:
  - PCB loss/materials
  - Loss for connectors
  - Minimum tx power
  - Implementation loss
    - Should this include crosstalk noise?
    - FEC coding gain? (computed directly)
    - Is 5 dB reasonable or overkill?
- Additional issues discussed in TF:
  - Temperature of full cable of 105C vs lower avg. temp not relevant to IL limit line, only to evaluation of cables
- Further potential:
  - -140 dBm/Hz was a PHY complexity trade off, not a hard limit. 3 dB could be had here
  - What margin is considered reasonable in the end? – depends on budgets included
  - Analysis of EMI margin directly



sedarat_3cy_01_01_05_21.pdf slide 8

Issues with “Margin Stacking”

- dB margins are NOT additive in dB if they come from additive noise sources

$$10\log10(\ 10^{-x1} + 10^{-x2}) \neq 10\log10(\ 10^{-(x1)}) + 10\log10(\ 10^{-(x2)})$$

- FEC “coding gain” should not be ‘bulk reduced’ as ‘dB margin’ when it has been calculated based on BER spec
  - Computed directly from impulses
  - Allocation of some FEC to EMI is also double-counting EMI margin
- 5 dB “implementation loss” on top of circuit board and spectral shaping losses seems excessive, and prone to double-counting
- TX power, RX noise, EMI, and crosstalk should all be referenced to the same test point prior to allocation
  - Magnitude of noise is significantly higher if it is referenced at MDI (like crosstalk) and PCB loss is considered

The elevated assumed RX noise relative to other technologies masks losses

Sedarat proposal, existing modeling has MUCH higher noise

- Assumed broadband noise of -140 dBm/Hz over 7.5 GHz
  - -41.25 dBm rms noise (75.0 nW)
  - 2.7 mVrms into 100 ohms
- 1e-12 (~7-sigma) noise ~19 mV

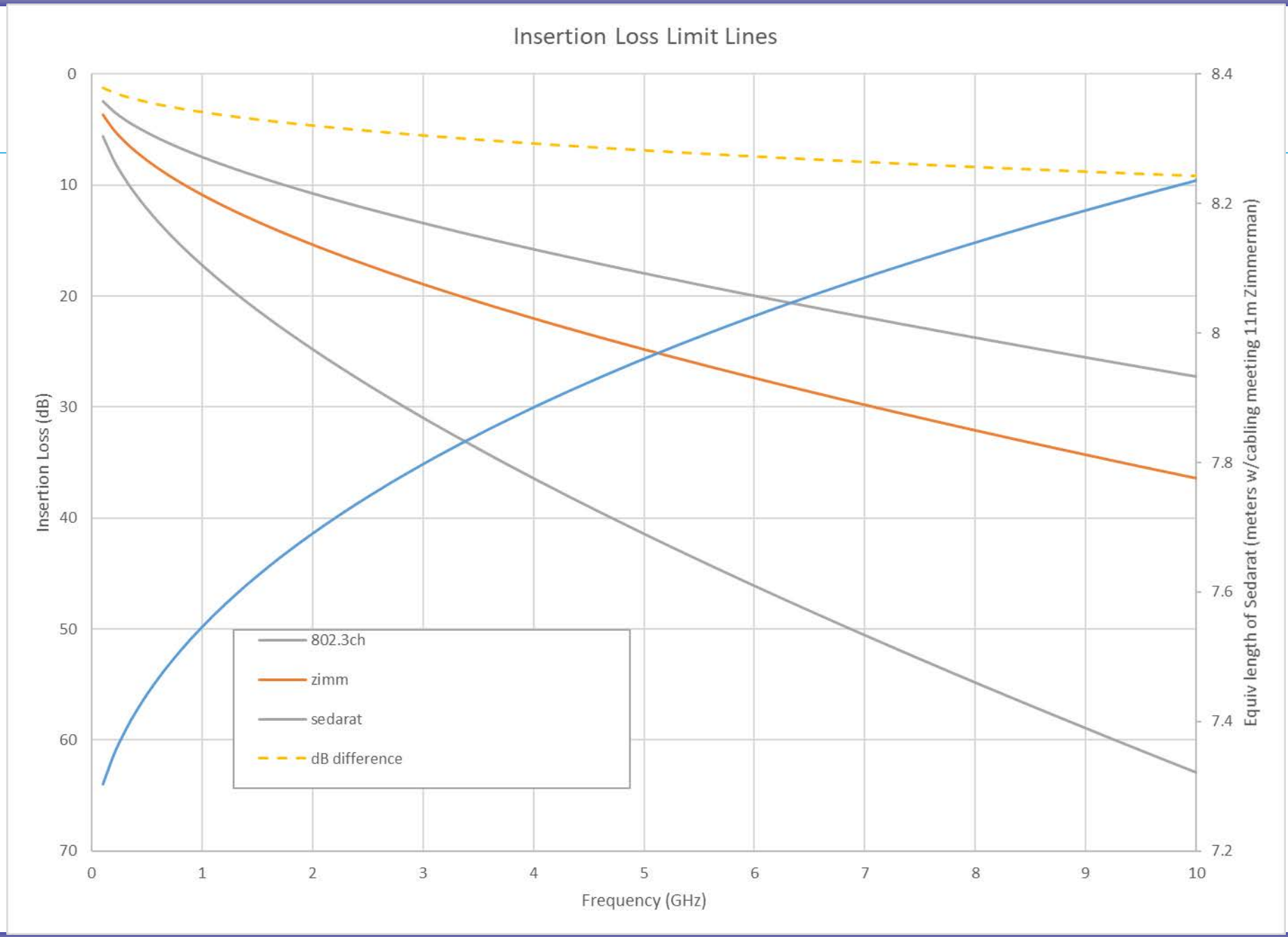
IEEE P802.3cy > 10 Gb/s Electrical Interface Task Force

- Broadband alien crosstalk level of -152 dBm/Hz over 3.5 GHz
  - -56.56 dBm rms noise (2.2 nW)
  - 0.47 mVrms into 100 ohms
- 1e-12 (~7-sigma) -> 3.3 mW

- Alien crosstalk is at similar levels to 802.3ch, -152 dBm/Hz crosstalk adds only 0.3 dB loss (NOT necessarily additive in dB to losses)
- RX noise impulse events mask EMI impulse events 5.7x larger than

Examples: Previous standards

- 1000BASE-T
  - Used 6 dB and 10 dB operating points to similar models
- 2.5GBASE-T/5GBASE-T (802.3bz)
  - 4 dB budget for all losses above alien crosstalk and EMC
    - Includes receiver noise, Suboptimal FEC decoding, equalization, echo cancellation & EMI
- 802.3ch (see prior)
- 25GBASE-CR/50GBASE-CR SERDES…


Insertion Loss Limit Lines
Insertion Loss (dB)
Equiv length of Sedarat (meters w/cabling meeting 11m Zimmerman)
Frequency (GHz)
0
10
20
30
40
50
60
70
8.4
8.2
8
7.8
7.6
7.4
7.2
0
1
2
3
4
5
6
7
8
9
10
802.3ch
zimm
sedarat
dB difference

Reconciliation

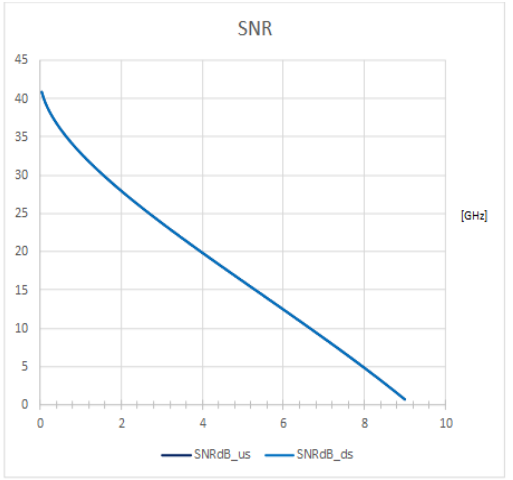
	dB IL at 7 GHz	Insertion Loss (dB) vs. freq (MHz)
802.3ch	29.80	$\leq 0.002\,f + 0.68\,f^{0.45}$
Nov. Strawman (zimmerman):	29.80	$\leq 0.002\,(f/2.5) + 0.68\,(f/2.5)^{0.45}$
Jan 12 Proposal (sedarat):	21.90	$\leq (6.5/12) \times (0.002\,f + 0.68\,f^{0.45})$
New Strawman proposal	25.85	$\leq 1.180 \times (6.5/12) \times (0.002\,f + 0.68\,f^{0.45}) = 0.00128\,f + 0.435\,f^{0.45}$
Mueller_3cy_01_12_01_20 SDP cable @ 95C	26.7 dB	(relaxation from 105C from wiencowski, based on model in Jonsson spreadsheet)

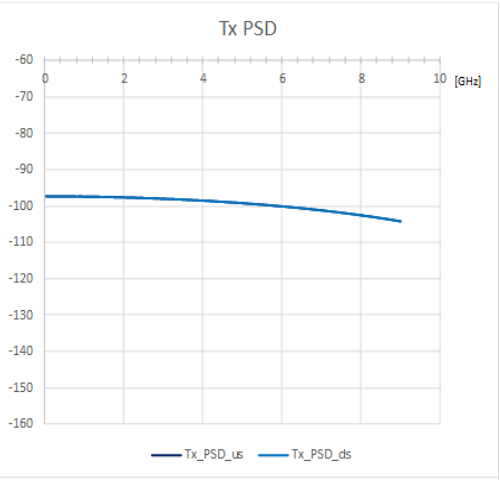
A possible path to 11m, single cable

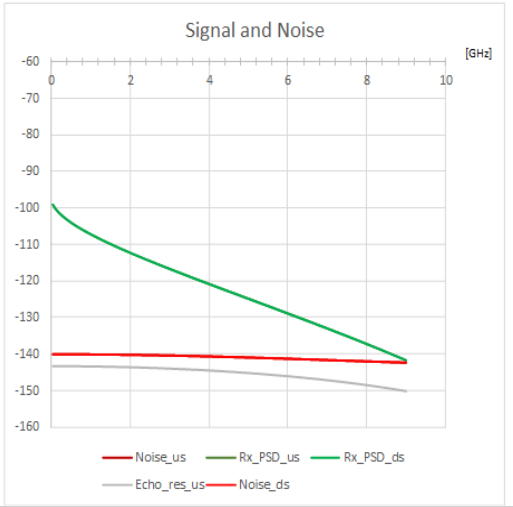
- Start with Mueller SDP cable
  - Mueller_3cy_01_12_01_20.pdf
  - PCB losses modeled
- Improve PHY front end noise 3 dB
  - To -143 dBm/Hz
  - ZOH modeled
- Reduce average temperature to 95C
  - Per Wienckowski profiles
- Maintain 5 dB budget for all implementations
  - (we've lowered the front-end noise)
- Positive margin
  - Still room for improvement on both PHY and cabling

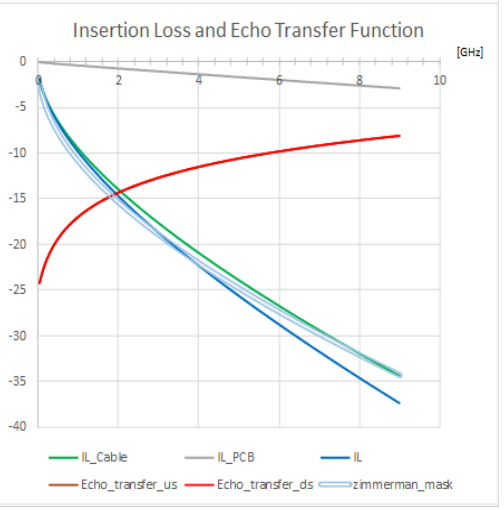
	Upstream	Downstream
Requirements		
Data Rate [Gbps]:	25	25
Target RS-FEC output BER:	1.00E-12	1.00E-12
Cable Length [m]:	11.000	11.000
Wire u-reflections limit:	jonsson*10_14_	jonsson*10_14_
Number of Connectors:	4	4
Modulation		
PAM Levels:	4	4
FEC Block Size (n):	360	360
FEC Data Size (k):	326	326
RS-FEC Correction Efficiency:	100%	100%
Bits per FEC Symbol:	10	10
TDD Time Duty-Cycle:	100%	100%
Framing Overhead:	1.875%	1.875%
Transmit Signal		
PSD-mask:	PSD_ZOH	PSD_ZOH
Transmit Power [dBm]:	0	0
Design Tradeoff		
Impulse Error Rate:	1.00E-04	1.00E-04
AFE-noise [dBm/Hz]:	-143	-143
EC cancelation [dB]:	6	6
EC Connector cancelation [%]:	100%	100%
Implementation Loss [dB]:	5	5
Simulation Parameters		
Cable Model:	mueller_3cy_01_12_01_20_sdp	
PCB model:	pcb_kadry_3cy_02_0820	
PCB trace length [m]:	0.0762	
Connector Echo Model:	Hard	
Temperature [°C]:	95	
Max Simulation Frequency:	9.00E+09	

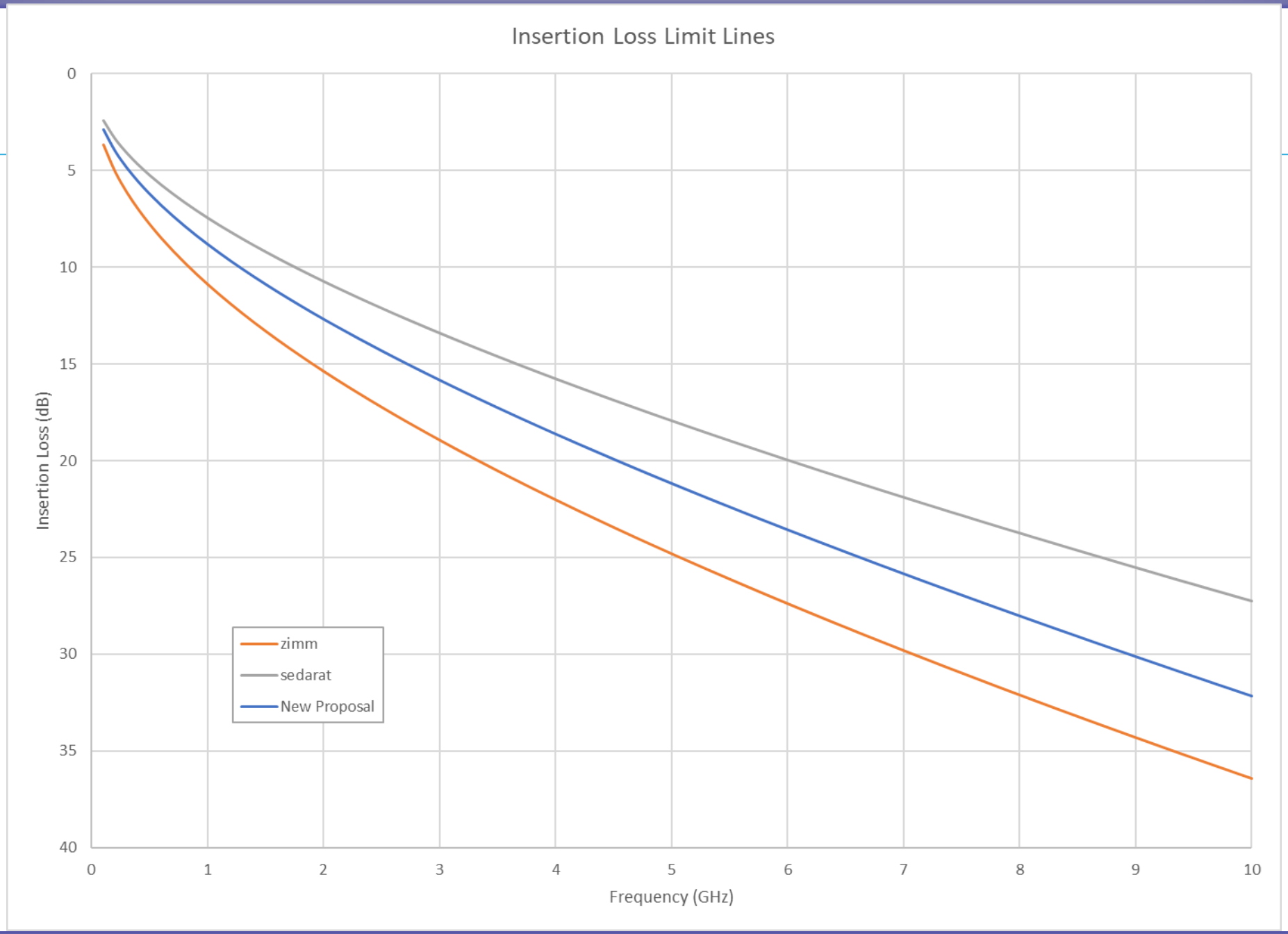
Calculated Values	Upstream	Downstream
Theoretical Slicer SNR [dB]:	22.31	22.31
Estimated Slicer SNR [dB]:	17.31	17.31
Required Slicer SNR [dB]:	17.20	17.20
SNR Margin [dB]:	0.11	0.11
Wire u-reflections [dB]:	-40.00	-40.00
Nyquist Frequency [GHz]:	7.03	7.03
Channel Insertion Loss @ Nyquist [dB]:	31.73	31.73
Cable Insertion Loss @ Nyquist [dB]:	29.38	29.38







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0
5
10
15
20
25
30
35
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0
1
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4
5
6
7
8
9
10
Frequency (GHz)
zimm
sedarat
New Proposal

Recommendation

- We are NOT ready to adopt baseline
- Economic feasibility demands balancing the relative cost factors between components
- PHY must share the pain – but cannot take all of it
  - Consider both receiver parameters, implementation, and operating margin – different vendors will divide these differently
- Recommend establishing a new strawman IL as our target, at least “splitting the difference” between cabling and PHYs
  - Not a baseline, still a strawman

THANK YOU!