Link Segment Proposal

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Acknowledgements

- This contribution draws upon the work of Steffen Graber in *graber_3dg_01_08302022* and *larsen_3GT10M_01_01192022 b* from me during the study group phase

Scope and outline

- This contribution makes an initial proposal for link segment specifications for 100BASE-T1L. Discussion and changes are hoped for and expected.
- Proposed list of link segment parameters to include:
  - Insertion Loss
  - Return Loss
  - TCL
  - ELTCTL
  - PSANEXT
  - PSAACRF
  - Delay
  - DC resistance

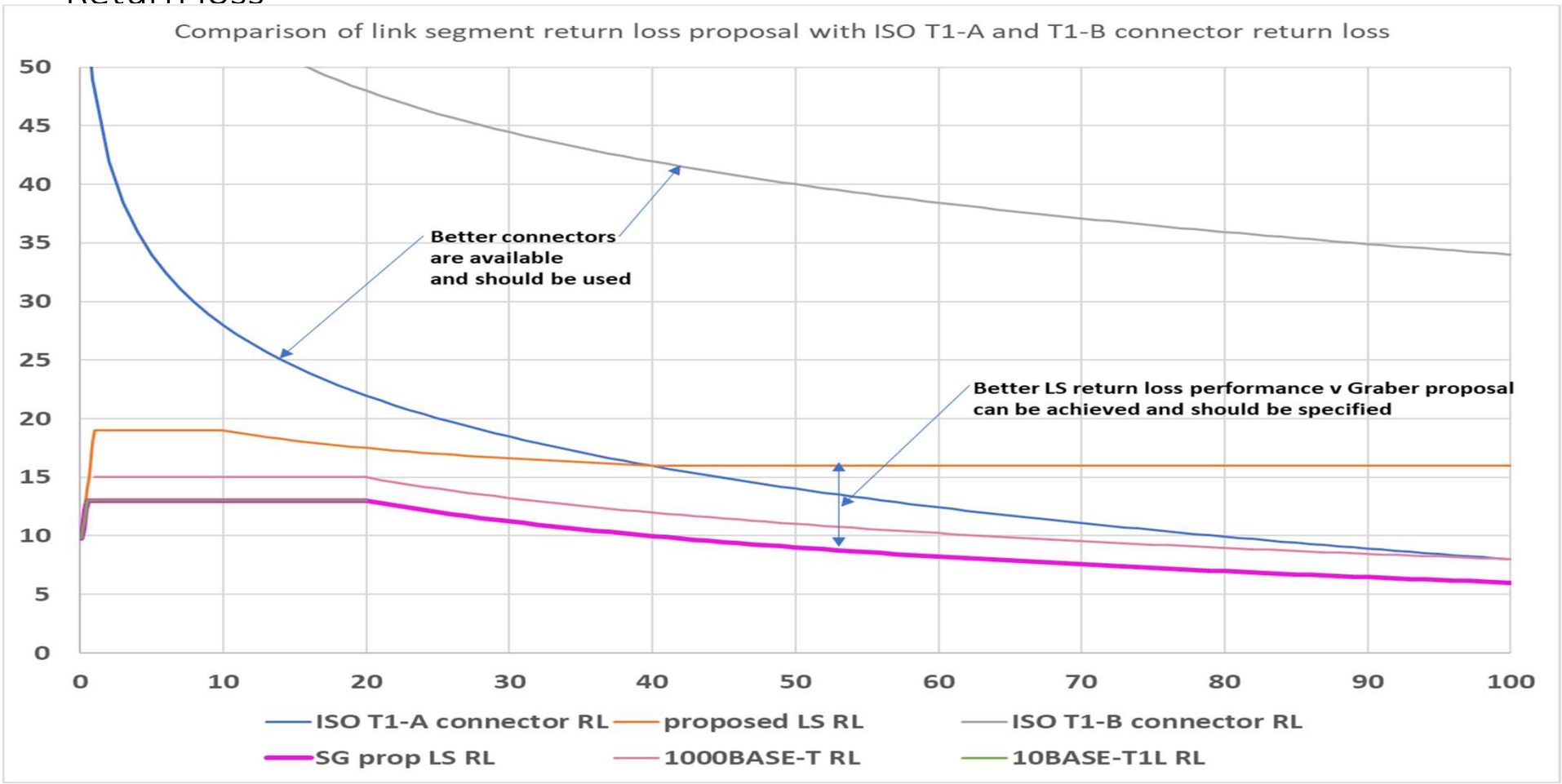
General thoughts

- Propose for now to cover the frequency range from 0.1 MHz to 100 MHz
  - This is surely a wide enough range
  - If we decide to narrow the range later we can do so easily, widening is not as easy
- Use the explicit terms ‘TCL’ and ‘ELTCTL’ and not the ambiguous term ‘mode conversion’
- All parameters to be specified over the same f range
- Use specifications from published cabling standards in cases where a useful specification exists

Insertion loss

- Propose 5(1.23sqrt(f) + .01f + .2/sqrt(f)) + 5*.02sqrt(f)
  - This is based on AWG 18 cable, 500 m, and 5 connectors
  - Exists in ANSI/TIA-568.5, SP-1000, has been scaled to 500 m length
  - Also exists in ISO draft of 11801-1 amd 1, for T1-A-1000, cable factor would be 5.05 to account for 10 m of patch cable with 50 % more loss

Return loss


Comparison of link segment return loss proposal with ISO T1-A and T1-B connector return loss
50
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
Better connectors are available and should be used
Better LS return loss performance v Graber proposal can be achieved and should be specified
ISO T1-A connector RL
proposed LS RL
ISO T1-B connector RL
SG prop LS RL
1000BASE-T RL
10BASE-T1L RL

Return loss

- Propose

Link Segment Return Loss	
Requirement	MHz range
9 + 10f	0.1-1
19	1-10
24-5log(f)	10-40
16	40-100

- Based on ISO T1-B
- Supportable by cable specs
- Supportable if the available better connectors are used
- Provides better PHY design margin
- Assures better cabling will be used

- Graber proposed

Link Segment Return Loss	
requirement	MHz range
9 + 8f	0.1-0.5
13	0.5-20
13-10log(f/20)	20-100

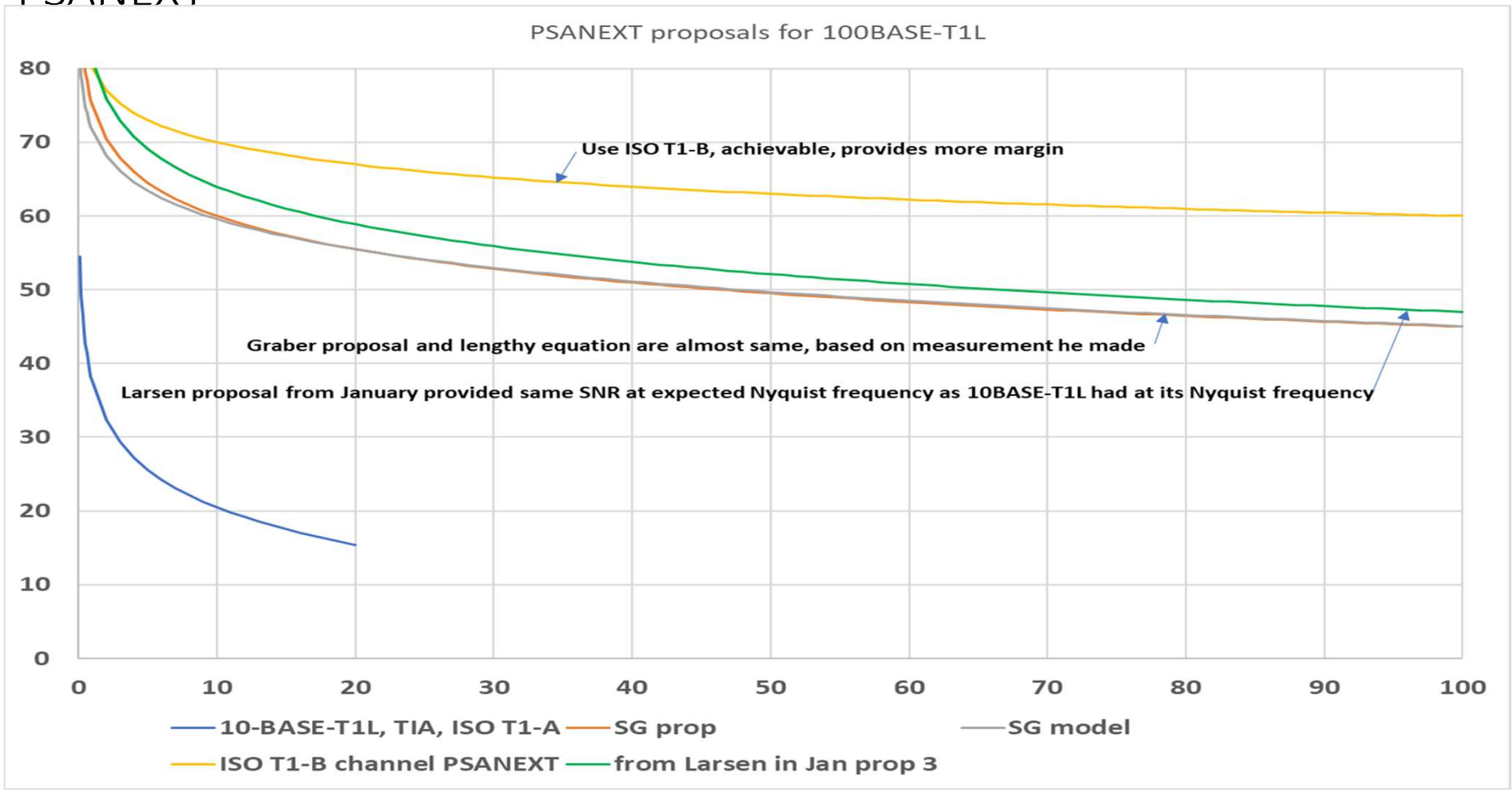
TCL

- Propose 50-20log(f/10)
- This is the same as TIA 568.5, and ISO (all classes) for MICE1 (MICE 2 and 3 are 10 and 20 dB higher)
- Frequency range to be the same 0.1 to 100 MHz; not extended to 200 MHz

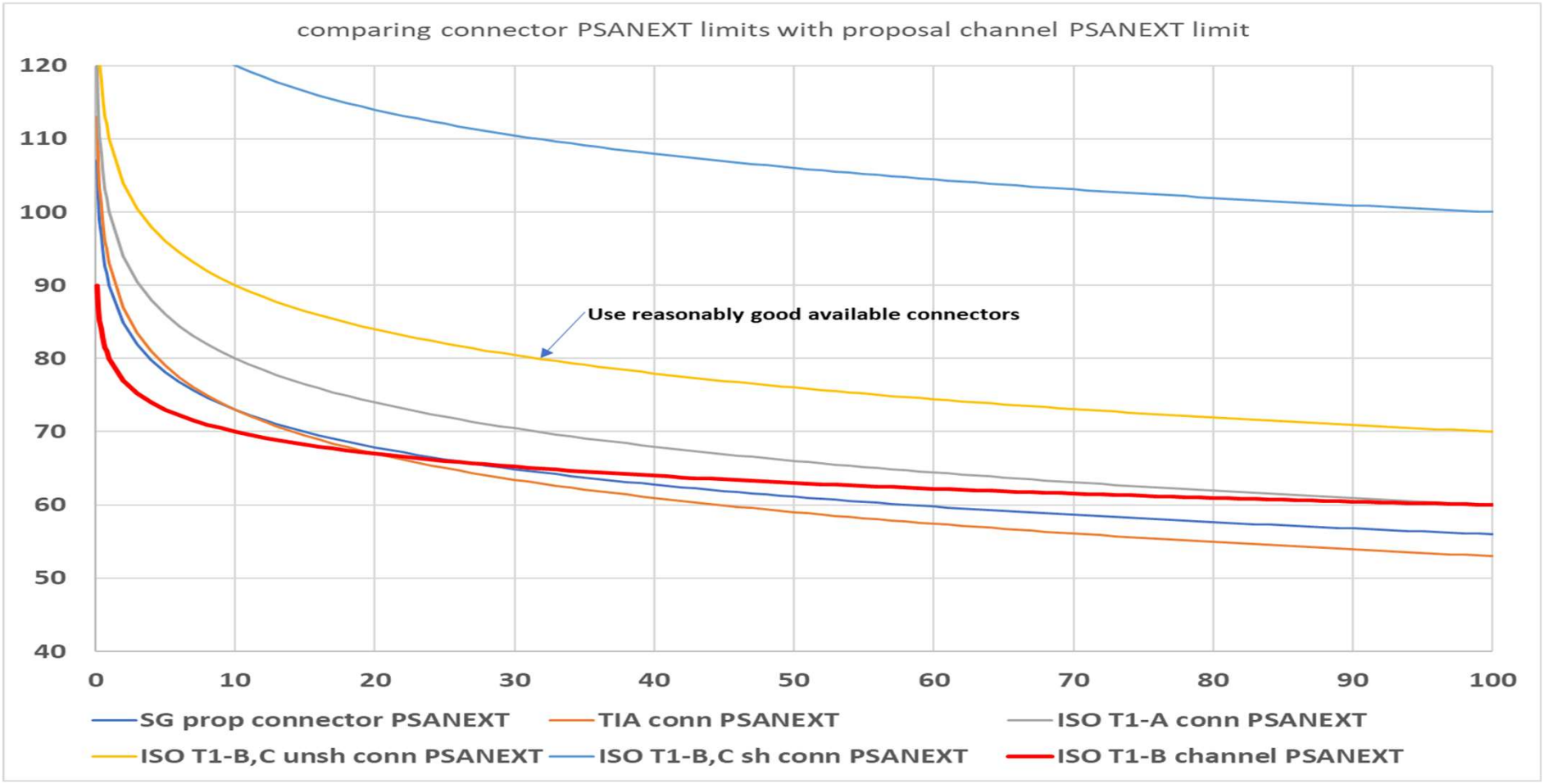
ELTCTL

- Propose 24-20log(f)
- This is a length dependent parameter
- Same as ISO T1-A-400 MICE1, similar length (different values for different lengths, MICE2 and MICE3 are 8 and 16 dB higher)
- Frequency range to be the same 0.1 to 100 MHz; not extended to 200 MHz
- Note, 10BASE-T1L has no far end mode conversion spec, only TCL
- Note, 4-pr PHYs do not have mode conversion specs, TCL or ELTCTL
- Note, other 1-pr PHYs that do have far end specs use TCTL

PSANEXT


PSANEXT proposals for 100BASE-T1L
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
Use ISO T1-B, achievable, provides more margin
Graber proposal and lengthy equation are almost same, based on measurement he made
Larsen proposal from January provided same SNR at expected Nyquist frequency as 10BASE-T1L had at its Nyquist frequency
10-BASE-T1L, TIA, ISO T1-A
SG prop
SG model
ISO T1-B channel PSANEXT
from Larsen in Jan prop 3

PSANEXT


comparing connector PSANEXT limits with proposal channel PSANEXT limit
120
110
100
90
80
70
60
50
40
0
10
20
30
40
50
60
70
80
90
100
Use reasonably good available connectors
SG prop connector PSANEXT
TIA conn PSANEXT
ISO T1-A conn PSANEXT
ISO T1-B,C unsh conn PSANEXT
ISO T1-B,C sh conn PSANEXT
ISO T1-B channel PSANEXT

PSANEXT

- Propose 60-10log(f/100), same as ISO T1-B
- Earlier proposals from Graber and Larsen also are rational options
- Connector slope should be 20 dB/decade based on known physics
- Using connectors that have to be spaced apart would be a disadvantage, for panel utilization and system design
- Well designed connectors that comply with the ISO T1-B unshielded spec, or similar, are available and should be used. Even better connectors are also available, not needed.

PSAACRF

- Propose 70-20log(f)
- In January I proposed 71-20log(f) to achieve the same level at the expected Nyquist frequency as 10BASE-T1L at its Nyquist frequency
- Today's proposal is based on the ISO T1-B requirement of 77-20log(f) scaled in length from 100 m to 500 m, and is only 1 dB different from the Nyquist based proposal
- Note that PSAACRF and not PSAFEXT is proposed
  - To be consistent with most other PHY and cabling far end crosstalk specifications
  - To follow natural laws more closely with simpler equations

Delay

- Assume 500 m length
- Assume 60 % velocity (likely conservative)
- Results in 2778 ns

DC resistance

- Assume AWG 18
- Resistance based on size requirement would be .0209 Ohms/m
- Assume connectors each .050 Ohms
- Results in 10.7 Ohms, or 21.4 Ohms for the loop resistance
- Alternatively AWG 16 would result in .0132 Ohms/m, 6.85 Ohms for each conductor, and 13.7 Ohms for the loop

Discussion

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