VITESSE®

Making Next-Generation Networks a Reality.

SNR Budget Analysis for 25 Gb/s over Backplane Channels

IEEE 802.3 100GCU Study Group
Interim Meeting, Incline Village, NV

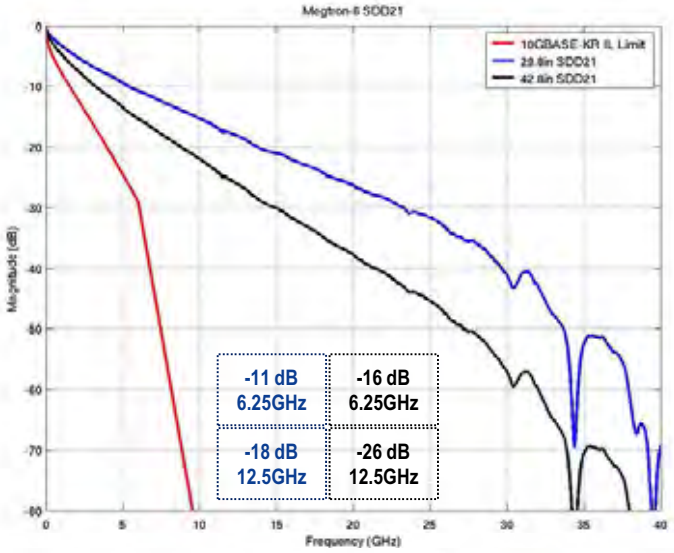
Ziad Hatab
May 24-25, 2011

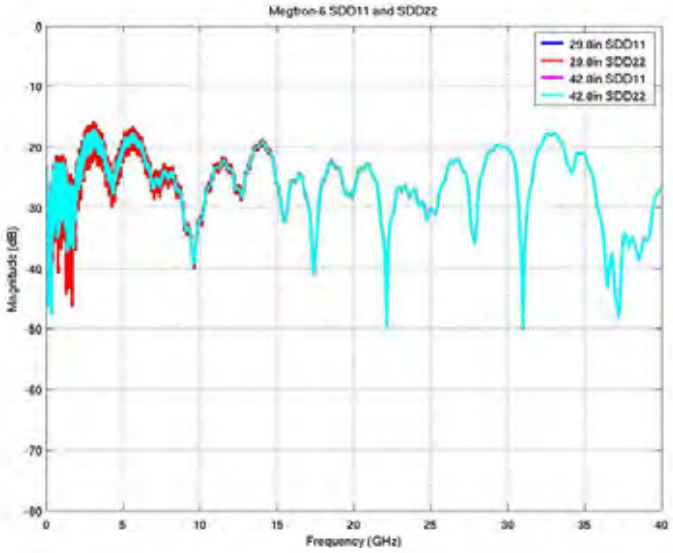
Outline

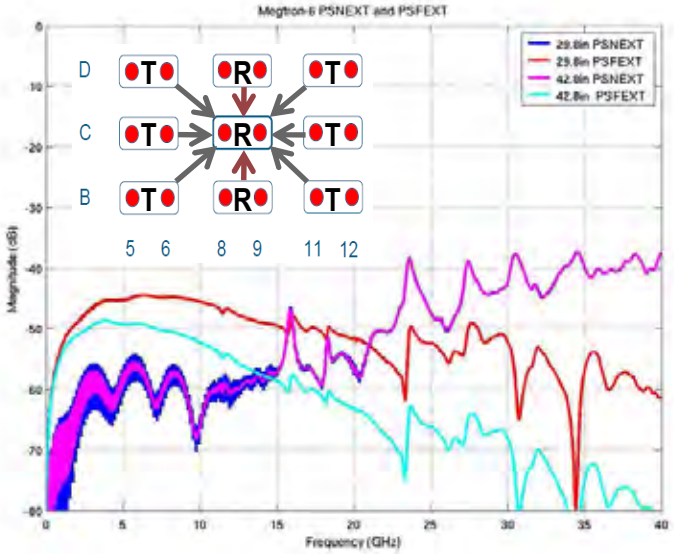
- IEEE 100GCU Channel Analysis:
  - Consider TE connectivity channel models[1]:
    - 29.8” simulated Backplane (BP) channel with Megtron-6 material
    - 42.8” simulated BP channel with Megtron-6 material
    - 29.8” simulated BP channel with Nelco4000-6 material
    - 42.8” simulated BP channel with Nelco4000-6 material
    - 27” measured BP channel with Megtron-6 material
    - Revised 27” measured BP channel with Megtron-6 material
  - Consider FCI channel models[1]:
    - 27.6” simulated BP 8 channels with Megtron-6 and Nelco4000-13SI material
  - Compare SNR margins at 25 Gb/s using NRZ and PAM-4
  - Investigate performance at 25-28 Gb/s
- Proposals on reach objectives

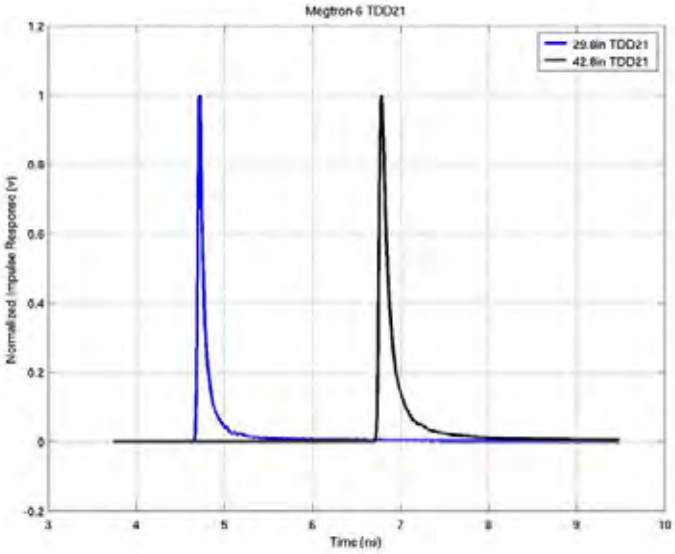
[1]: http://www.ieee802.org/3/100GCU/public/channel.html

TE STRADA Whisper Megtron-6 Channels: 29.8” & 42.8”

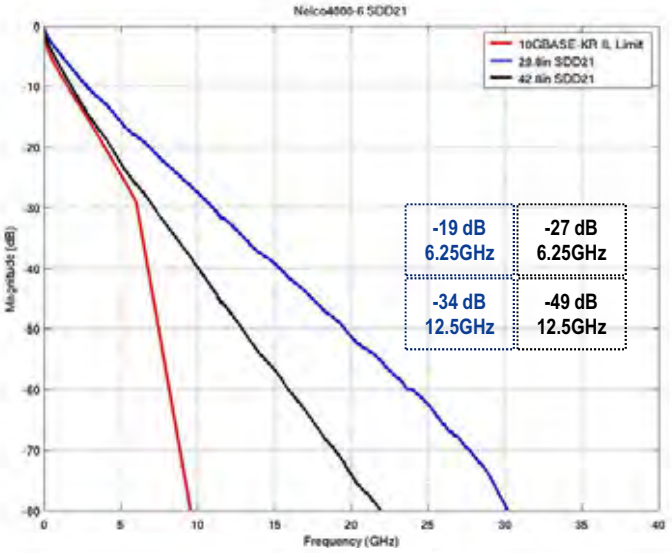


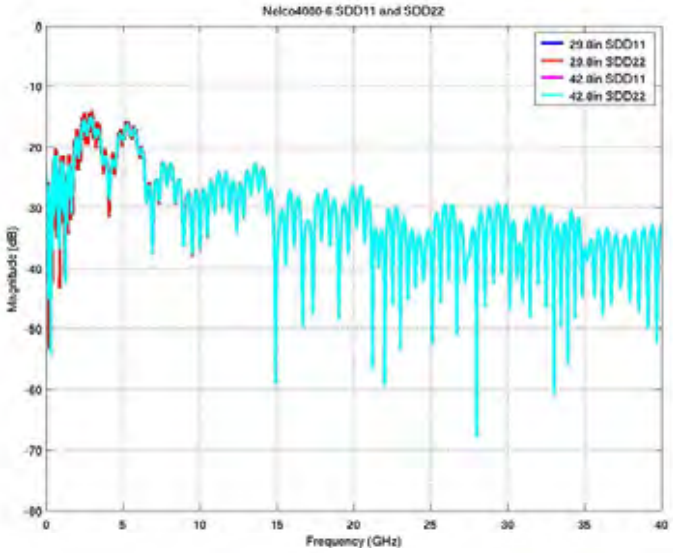


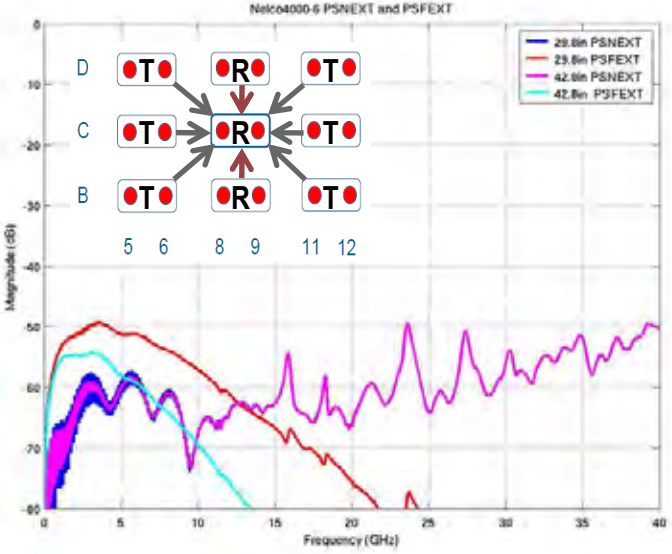


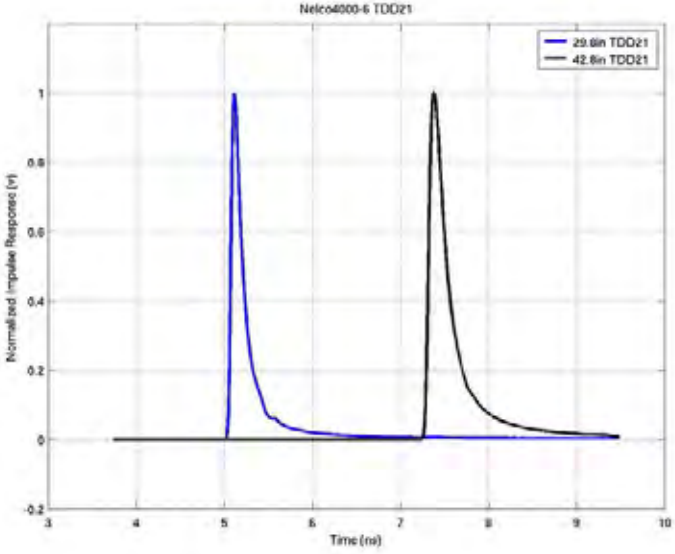


TE STRADA Whisper Nelco4000-6 Channels: 29.8” & 42.8”

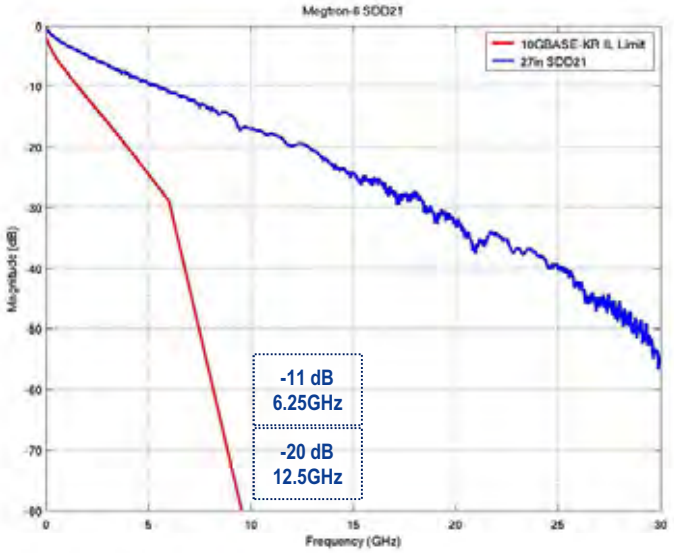


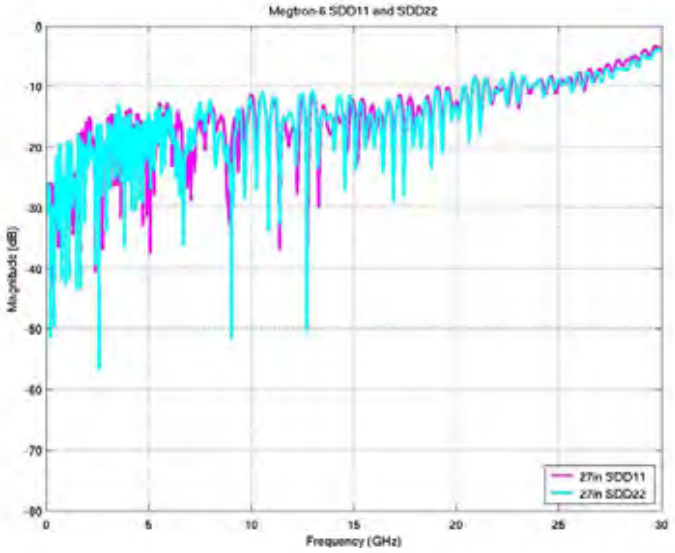


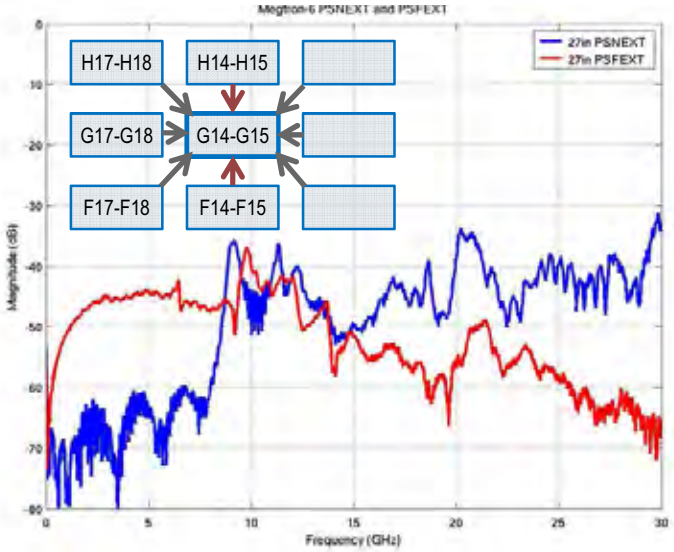


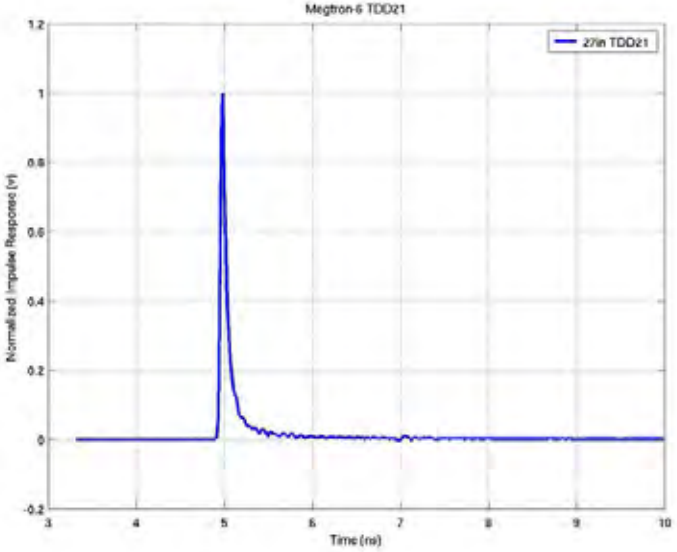


TE STRADA Whisper Megtron-6 Channel: 27”

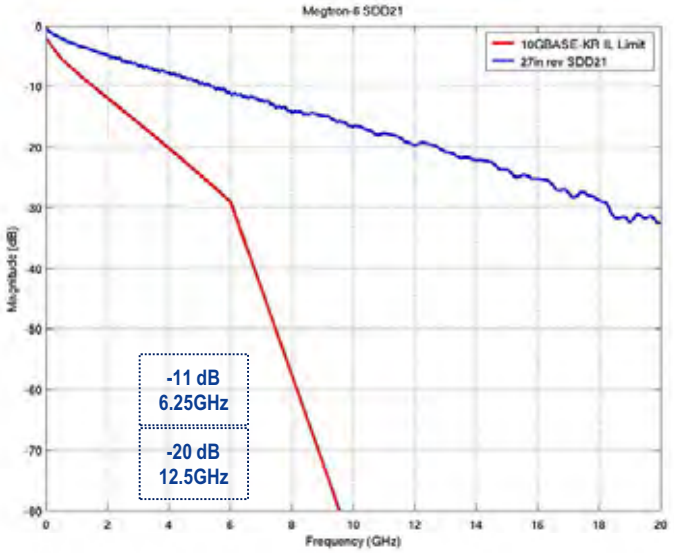


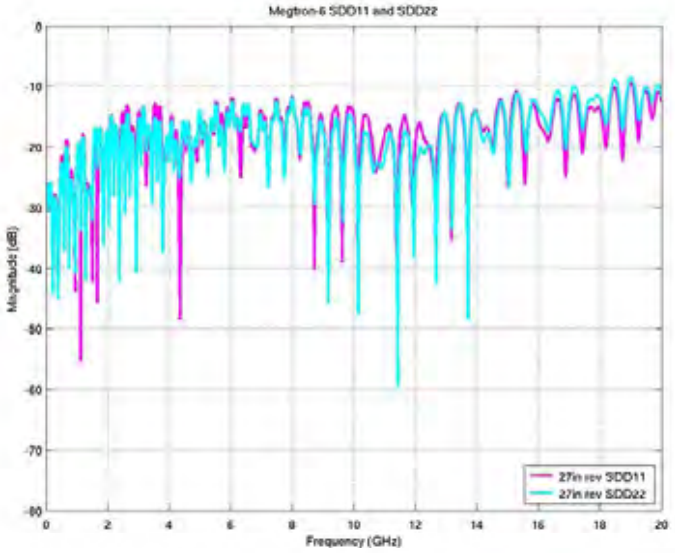


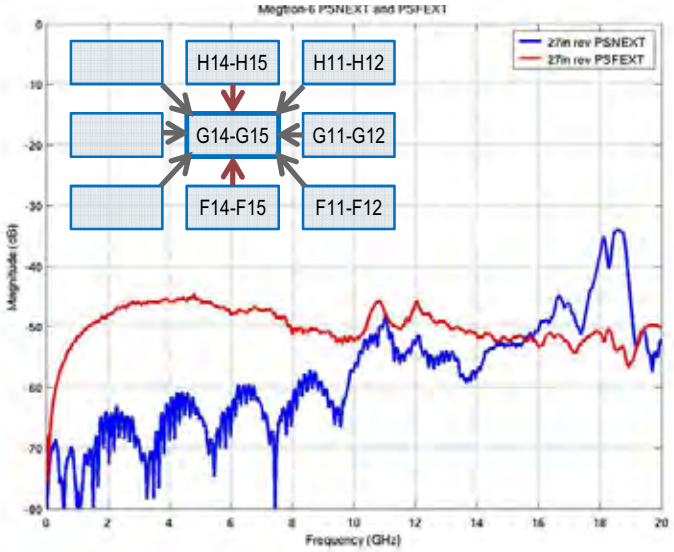


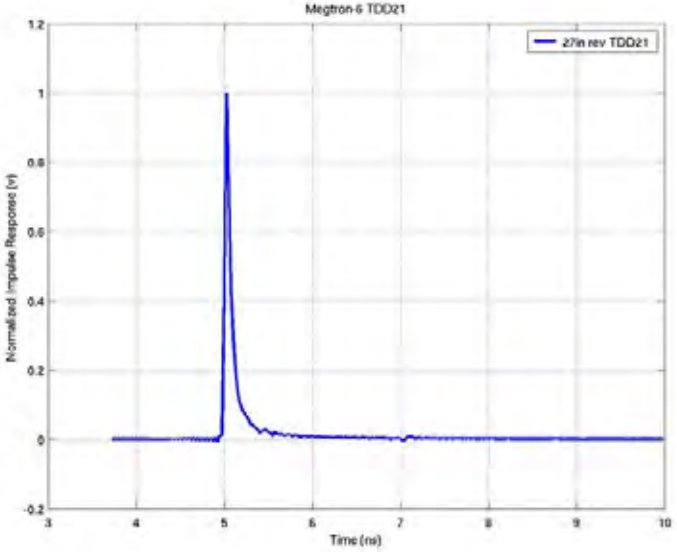


Revised TE STRADA Whisper Megtron-6 Channel: 27”

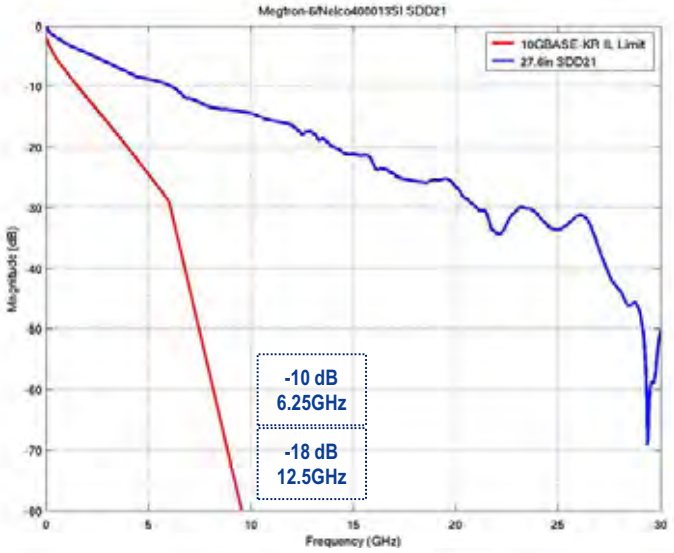


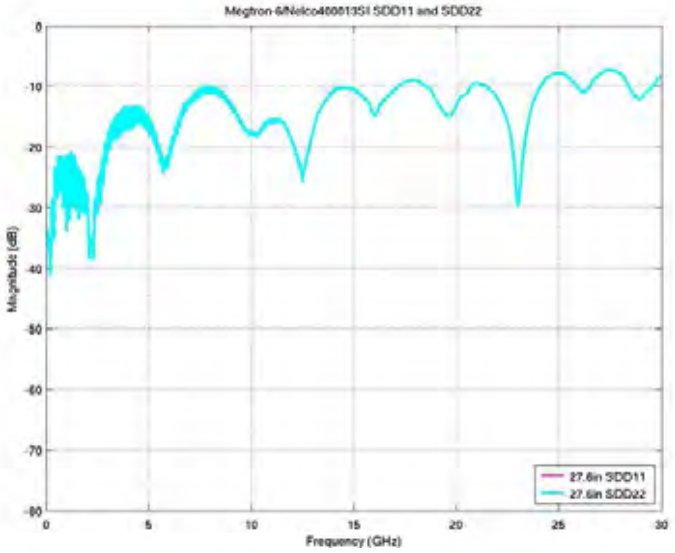


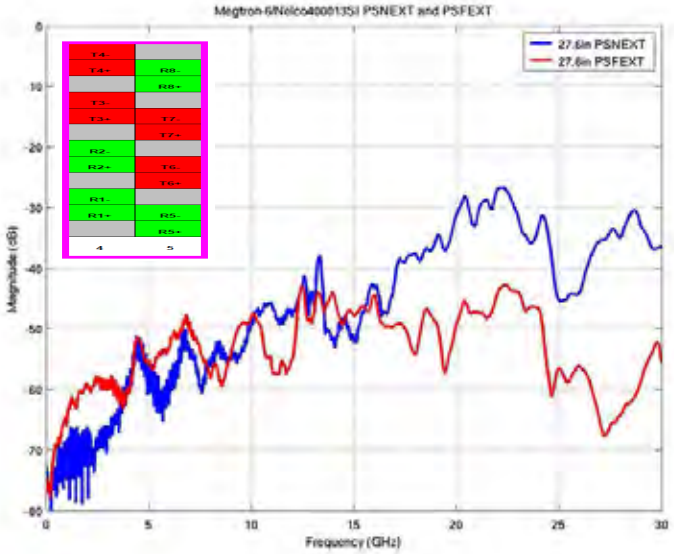


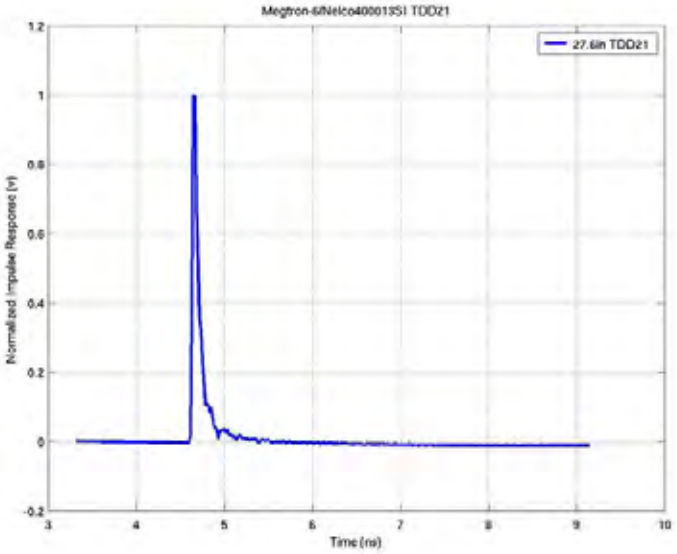


FCI Megtron-6/Nelco400013SI Channel: 27.6”





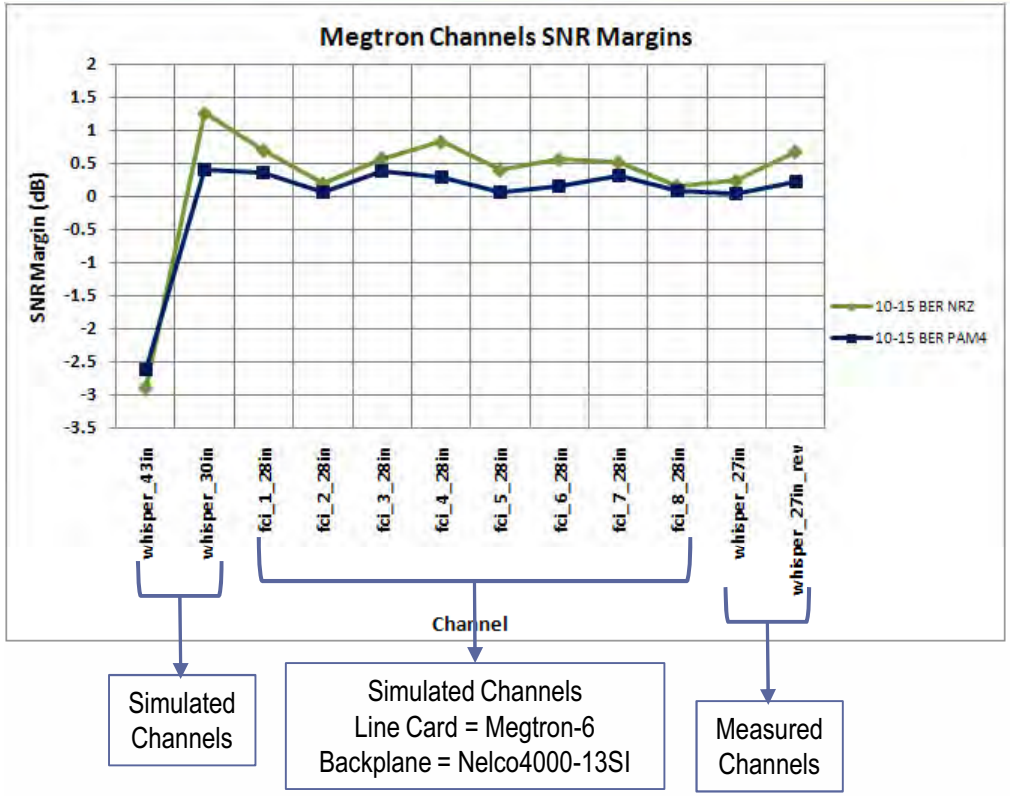


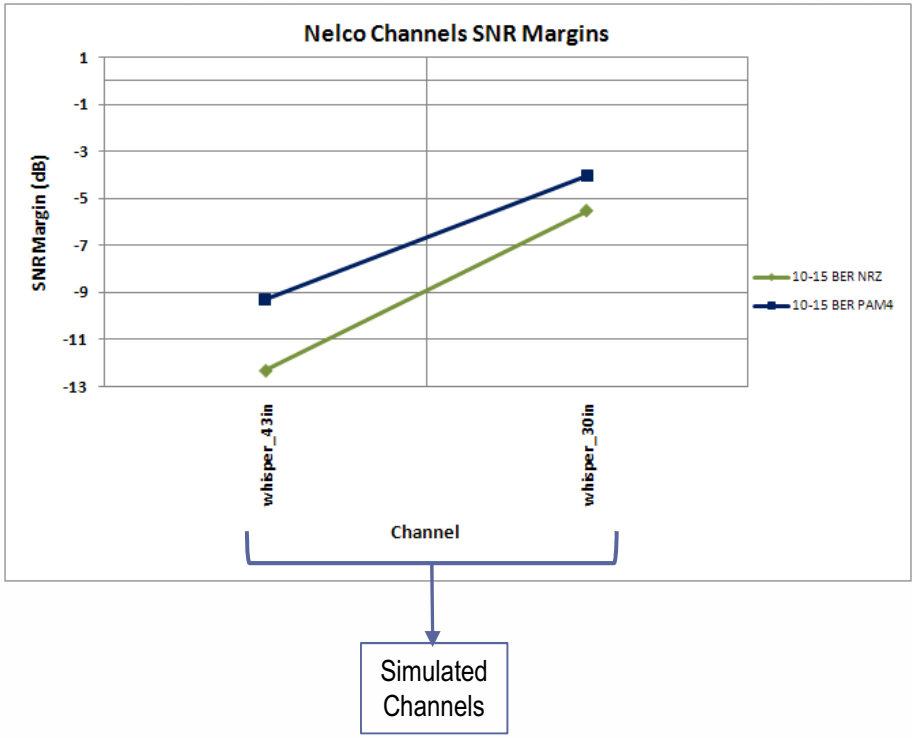


Simulations Parameters

Channel	Channel	Link	Transmitter	Receiver
Transmitter	Receiver	**Bit Rate:** 25 Gb/s	**Test Pattern:** 64B/66B	**Random Noise:** -140 dBm/Hz (1.18 mv RMS PAM-4) (1.67 mv RMS NRZ)
Device Package: Pkg35mm_T21mm115ohm LoXtalk_BGALoXtalk.s8p	**Device Package:** Pkg35mm_T21mm115ohm LoXtalk_BGALoXtalk.s8p	**Modulation:** PAM-4 NRZ	**Vpp:** 1.0 v	**Deterministic Jitter:** NA
Device Package Crosstalk: NA	**Device Package Crosstalk:** NA	**Signaling Rate:** 12.5 GHz 25 GHz	**De-Emphasis:** NA	**Random Jitter:** NA
R_1: 50 ohm	**R_2:** 50 ohm	**Number of symbols simulated:** 50000	**Deterministic Jitter:** 11.3 ps (peak-to-peak) Sinusoidal at 5 MHz	**CT Filter:** NA
C_1 : 0 F	**C_2:** 0 F	**Target symbol error ratio:** 10^{-15}	**DCD:** NA	**Equalizer Structure:** DFE: 12 FFE: 8 (T-Spaced) LMS
Near-End Crosstalk: 6 aggressors (TE) 4 aggressors (FCI) Asynchronous Victim Tx replicated			**Random Jitter:** 6.6 ps (RMS)	**CDR:** Ideal
Far-End Crosstalk: 2 aggressors (TE) 3 aggressors (FCI) Asynchronous Victim Tx replicated				

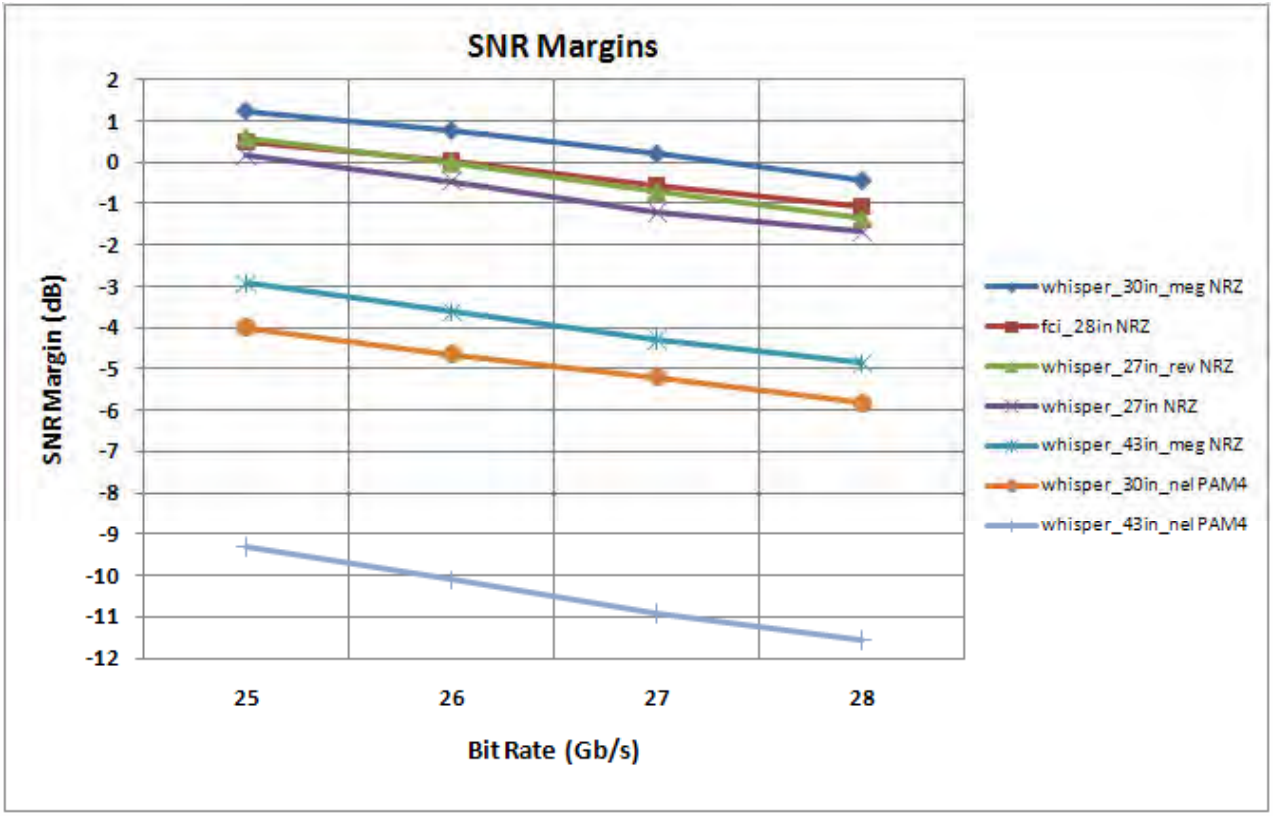
SNR Margin Results at 25 Gb/s





- For Megtron-6 Channels:
  - PAM-4 and NRZ have comparable performance:
    - 7 dB ≤ IL at $f_{Nyquist\text{-}PAM4} - f_{Nyquist\text{-}NRZ} \leq 10$ dB
- For Nelco4000-6 Channels:
  - PAM-4 has 3 dB of additional SNR margin over NRZ at 43".
  - PAM-4 has 1.5 dB of additional SNR margin over NRZ at 30".

SNR Margin Results for 25-28 Gb/s



- There is about 0.6 dB of SNR margin loss per 1Gb/s.
- Simulated levels of crosstalk, return loss, and insertion loss deviation from TE STRADA Whisper Nelco channels are relatively low:
  - Actual 10GBASE-KR channels expected to have higher impairment levels.
  - 25Gb/s Nelco margins may be lower.
  - Account for this uncertainty by increasing required margin.

Summary

Channel	Channel Data Type	Total Length (inches)	Materials (Line Card Backplane)	Line Code	IL at 6.25 GHz (dB)	IL at 12.5 GHz (dB)	Required FEC NCG[1] for 0 dB margin at 10^{-15} BER (dB)	Required FEC NCG for 3 dB margin at 10^{-15} BER (dB)
TE Whisper	Simulated	42.8	Nelco 4000-6 Nelco 4000-6	PAM-4	-27	-49	**9.3**	**12.3**
TE Whisper	Simulated	29.8	Nelco 4000-6 Nelco 4000-6	PAM-4	-19	-34	**4.0**	**7.0**
TE Whisper	Simulated	42.8	Megtron-6 Megtron-6	NRZ	-16	-26	**2.9**	**5.9**
TE Whisper	Simulated	29.8	Megtron-6 Megtron-6	NRZ	-11	-18	**0**	**1.7**
FCI	Simulated	27.6	Megtron-6 Nelco 4000-13SI	NRZ	-10	-18	**0**	**2.5**[2]
TE Whisper	Measured	27	Megtron-6 Megtron-6	NRZ	-11	-20	**0**	**2.8**
TE Whisper (Rev)	Measured	27	Megtron-6 Megtron-6	NRZ	-11	-20	**0**	**2.3**

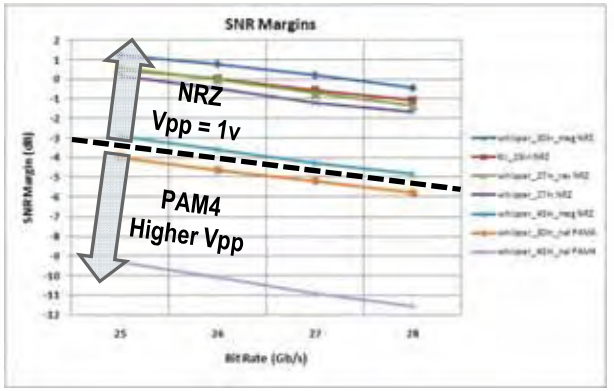
[1]: Net Coding Gain
[2]: Average over 8 channels

Improving SNR Margins

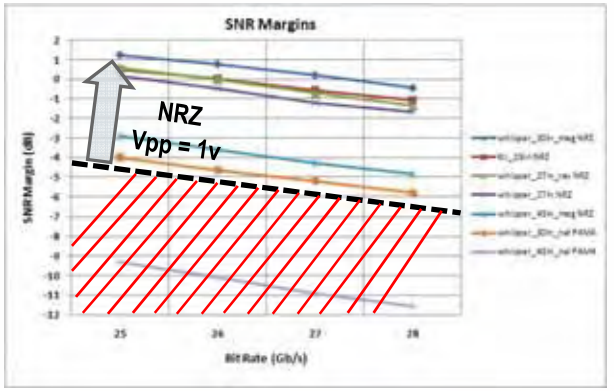
- Given nature of channels provided, not much can be done to improve performance on Nelco channels:
  - Low crosstalk levels
  - Low insertion loss deviation (ILD) levels
  - Low return loss (RL) levels
  - 8FFE/12DFE equalizer is very close to optimum
- Need to increase V_{pp} beyond 1v to improve SNR margins on Nelco channels in particular above 30".
- V_{pp} = 1v seems adequate for Megtron channels up to 40" and Nelco channels up to 30".

Proposed Reach Objectives

- Proposal 1:
  - Support for 10GBASE-KR channels up to 40” (1m):
    - PAM-4
    - Higher V_{pp}
    - FEC with NCG according to V_{pp}
  - Support for 100GCU channels up to 40” (1m):
    - NRZ
    - V_{pp} = 1v
    - FEC with NCG of 6 dB



- Proposal 2:
  - Support for 10GBASE-KR channels up to 30” (0.75m) and 100GCU channels up to 40” (1m) :
    - NRZ
    - V_{pp} = 1v
    - FEC with NCG of 7 dB
    - On measured 10GBASE-KR channels with higher levels of crosstalk, return loss, and reflections, V_{pp} and the required FEC NCG may need to increase or 30” reach needs to decrease.

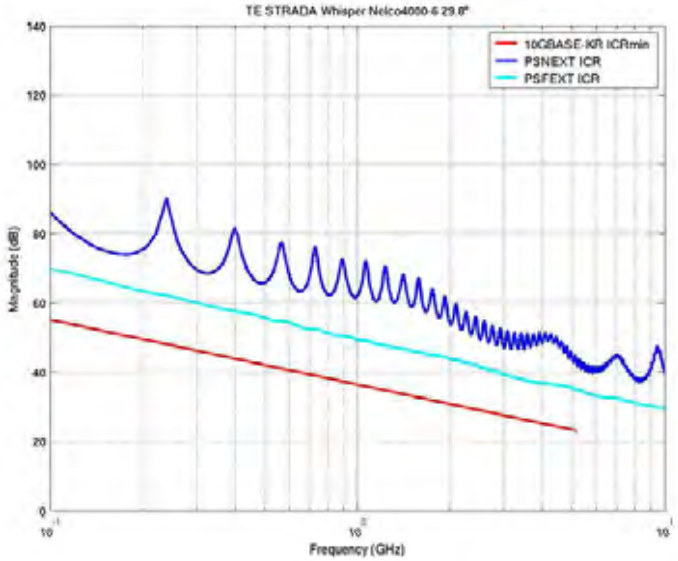


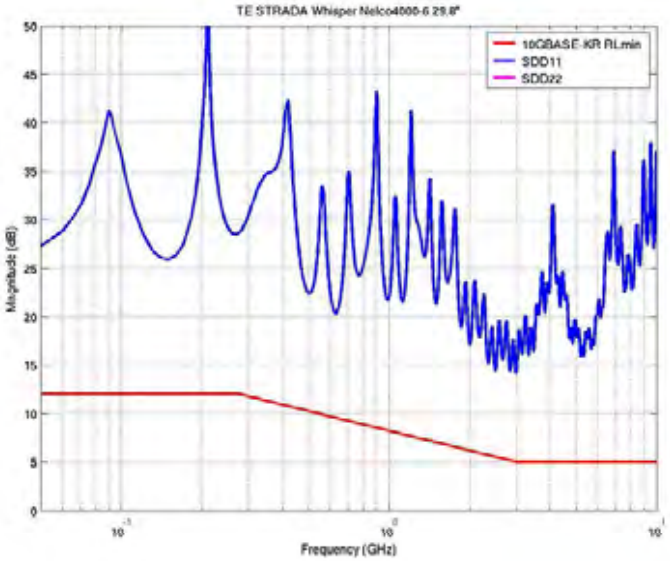
VITESSE®

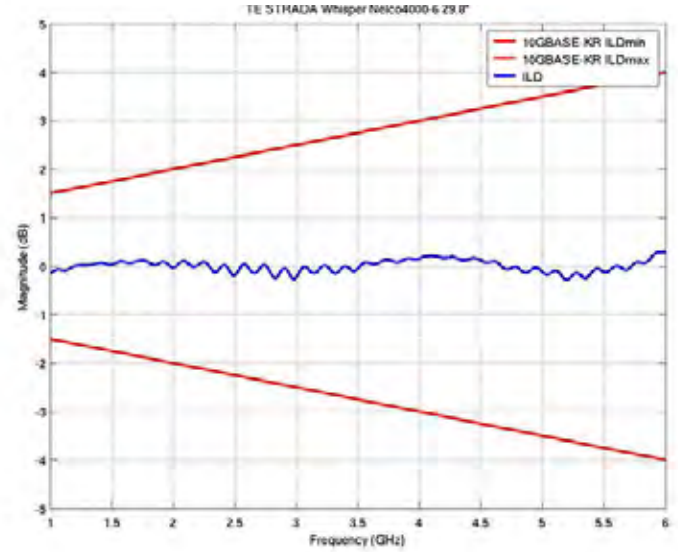
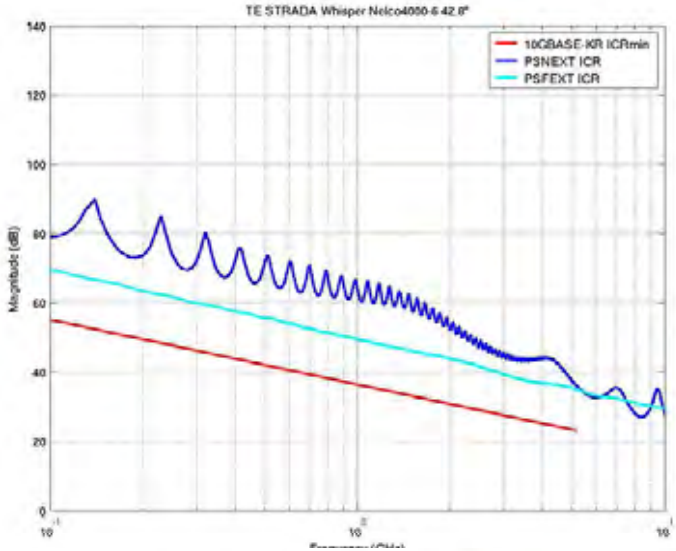
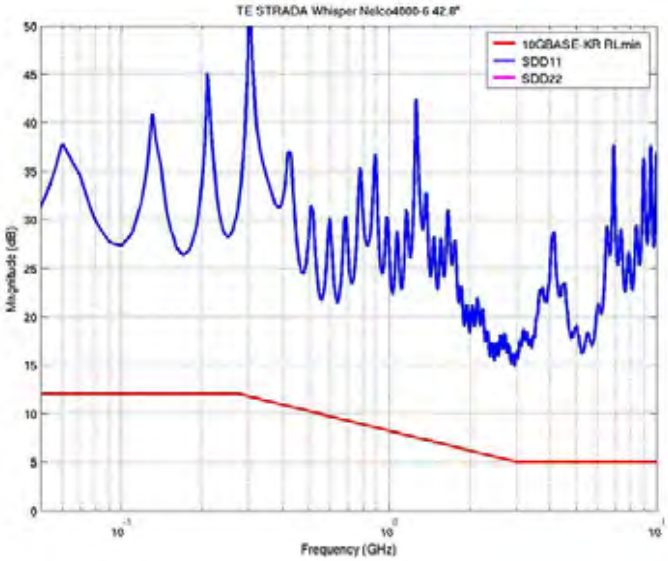
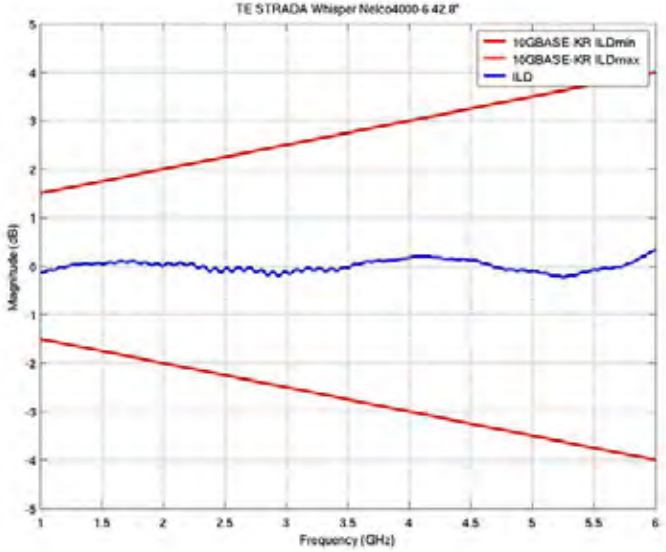
Making Next-Generation Networks a Reality.

BACKUP SLIDES

TE STRADA Whisper Nelco4000-6 Channel: 29.8”







TE STRADA Whisper Nelco4000-6 Channel: 42.8”