SNR MDFEXT and MTF specifications

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Purpose

- Improve the meaningfulness of the MTF specification and resolve MTF specification conundrums

Agenda

- ❑ Review ICN
- ❑ About for FEXT
- ❑ Proposal SNR_{FEXT}
- ❑ Addressing IL variability MTF concerns
- ❑ Summary

Review ICN (Eq. 85-28 to 85-32)

- $w_{nt}(f_n) = \frac{A_n^2}{f_b} sinc\left(\frac{f_n}{f_b}\right)^2 \left[\frac{1}{1+\left({f_n}/{f_{nt}}\right)^4}\right]\left[\frac{1}{1+\left({f_n}/{f_r}\right)^8}\right]$
- $w_{ft}(f_n) = \frac{A_f^2}{f_b} sinc\left(\frac{f_n}{f_b}\right)^2 \left[\frac{1}{1+\left({f_n}/{f_{ft}}\right)^4}\right]\left[\frac{1}{1+\left({f_n}/{f_r}\right)^8}\right]$

- $\sigma_{nx}^2 = 2\Delta f \sum w_{nt}(f_n) 10^{-MDNEXT_{loss}(f_n)/10}$ … $MDNEXT\ ICN = \sigma_{nx}$
- $\sigma_{fx}^2 = 2\Delta f \sum wf_t(f_n) 10^{-MDFEXT_{loss}(f_n)/10}$ … $MDFEXT\ ICN = \sigma_{fx}$
- ICN = $\sqrt{\sigma_{nx}^2 + \sigma_{fx}^2}$

MDNEXT and NDFEXT ICN from a System perspective

- The voltage A_{nt} is independent of the victim transmitter
- The voltage A_{ft} is not independent of the victim transmitter

- The combination of MDNEXT and MDFEXT ICN is system use case dependent
  - Background: Generalized ccICN[1] addressed situ crosstalk for small interconnect components

[1] SJ Moon, S Wu, M Mazumder, "Generalized ccICN (component contribution Integrated Crosstalk Noise) for PAM-N", 2021 IEEE 25th Workshop on Signal and Power Integrity, (Siegen, Germany)

About MDFEXT

- The MDFEXT noise generated at a connector is modified by the victim preceding channel.
- Not so much true for MDNEXT.
  - It is not modified by the preceding victim channel.
- Hence MDFEXT ICN is quite context sensitive
- Combine MDFEXT ICN and MDNEXT ICN is an overly pessimistic because of the high dependance of MDFEXT ICN on context.
- Context sensitivity can be removed by changing MDFEXT into an SNR removing the dependance on A_{ft} while including PAM effects

New Concept: SNR_{MDFEXT}

- $SNR_{MDFEXT} = normalized\ signal\ dB\ power - normalized\ MDFEXT\ crosstalk\ dB\ power$

  or

- $SNR_{MDFEXT} = 10log_{10}\left(\frac{\hat{P}_{signal}}{\hat{\sigma}^2_{mdfext}\sigma_x^2}\right)$
  - $\hat{P}_{signal} = 2\Delta f \sum w(f) 10^{-IL(f)/10}$, Normalized signal power
  - $\hat{\sigma}^2_{mdfext} = 2\Delta f \sum w(f) 10^{-MDFEXT_{loss}(f)/10} = ICN/Aft$, Normalized MDFEXT power

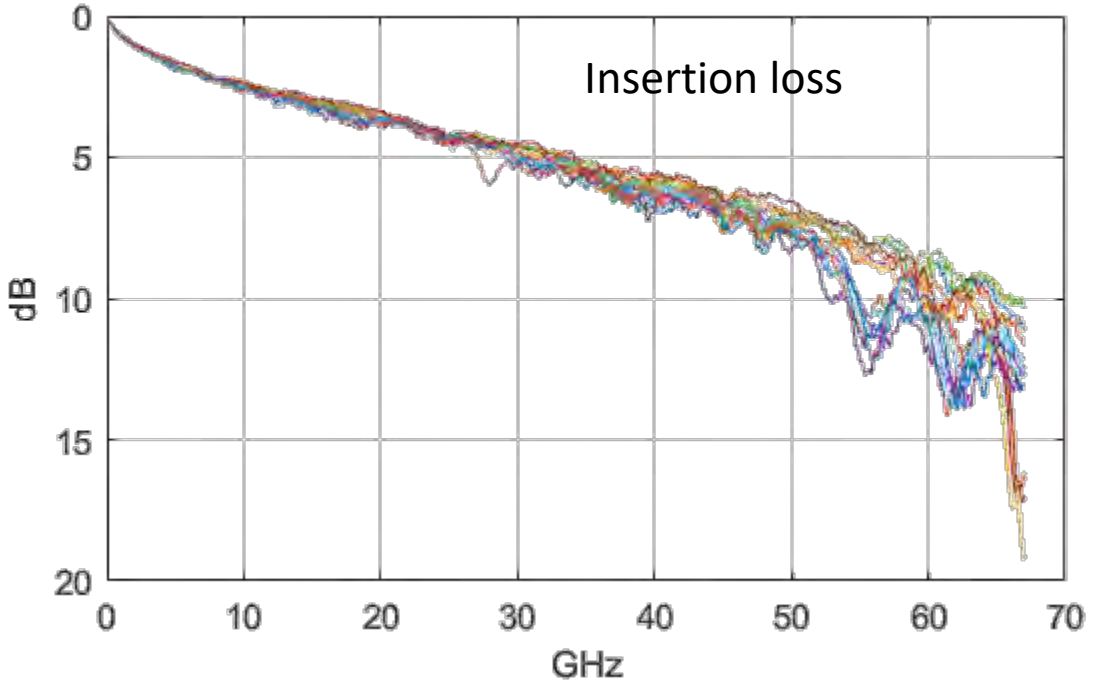
    $w(f) = \frac{1}{f_b} sinc\left(\frac{f}{f_b}\right)^2 \left[\frac{1}{1+\left(f/f_{ft}\right)^4}\right]\left[\frac{1}{1+\left(f/f_r\right)^8}\right]$ …from eq. (93A–57) note: f_{tf} and f_t are assumed to be the same

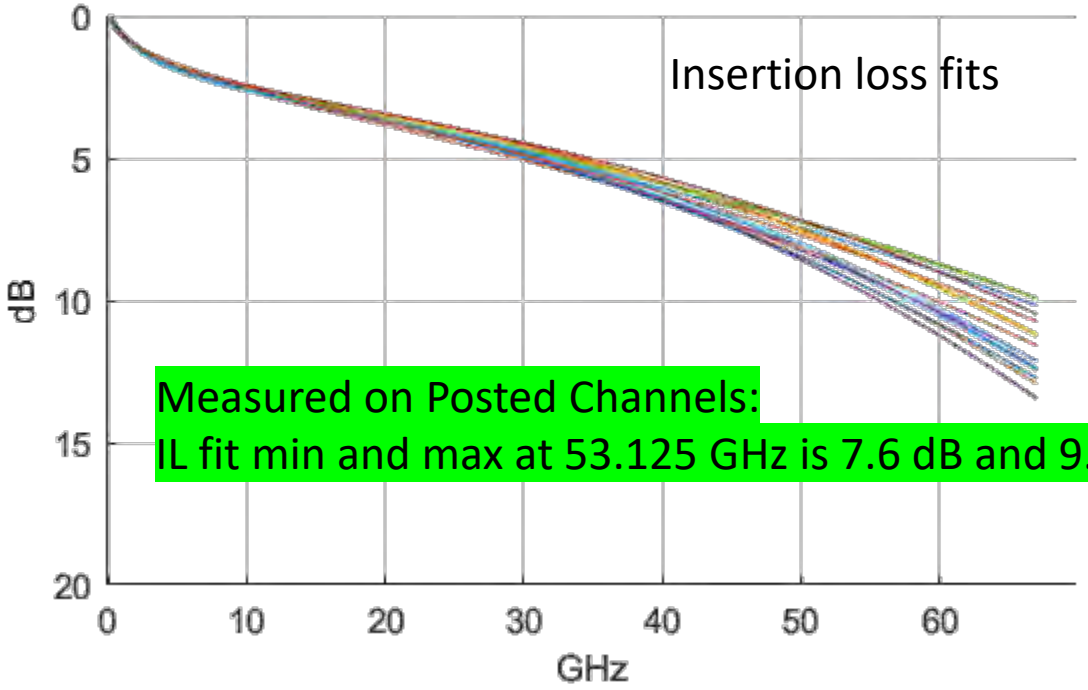
    $IL(f) = -20log_{10}(|sdd21(f)|)$

    $\sigma_x^2 = \frac{(L^2-1)}{3(L-1)^2}$ …note: L is number of PAM levels

- Data: Range of SNR_{MDFEXT} for posted crosstalk files is between 40.8 dB and 45.1 dB

IL Variability is a Spec Conundrum





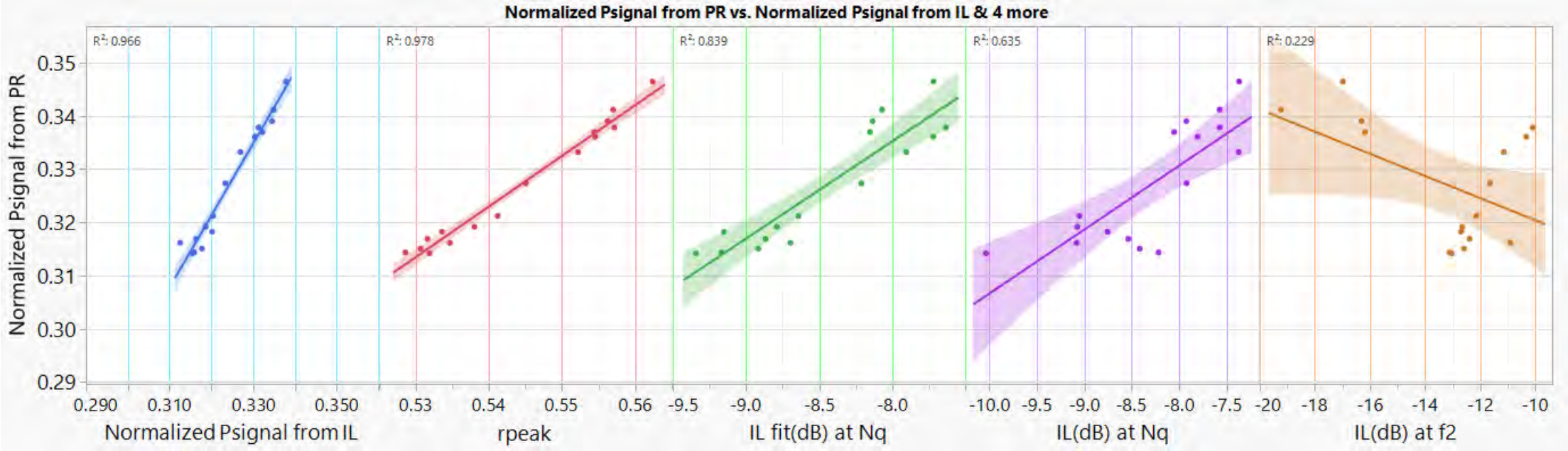
Measured on Posted Channels:
IL fit min and max at 53.125 GHz is 7.6 dB and 9.3 dB)

- IL mask variation is around 9 dB at 67 GHz
- IL variation at 53.125 GHz is ~ 2.7 dB
- This makes IL masks problematic

- IL fit variation at 53.125 GHz is ~ 1.7 dB
- FOM_ILD is between (0.08 dB and 0.19 dB)
- A better control could be SNR_ISI but requires time domain analysis.

An Interesting look at correlations

$\widehat{P}_{signal}$ is highly correlated to rPeak and "IL fit at Nyquist"



$\widehat{P}_{signal}$ ranges between 0.31 and 0.34

$\widehat{P}_{signal}$ specification will take care of IL shape deviations

Summary and Proposal

- ICN Simplification
  - Remove the ICN total specification
  - Keep MDNEXT ICN
  - Replace MDFEXT ICN with SNR_{MDFEXT} min of 40 dB
    - Removes A_{ft} dependance
- IL related: Replace IL masks and IL reference line with
  - Option A: Using frequency domain only
    - Use P_{signal} min max (0.31 and 0.34)
      - Corresponds to IL fit min and max at 53.125 GHz (7.6 dB and 9.3 dB)
    - Rely on FOM_ILD to cover what was covered with the IL mask specification
  - Option B: Using time domain
    - Specify rPeak min and max (.53 and .56)
    - SNR_ISI min (TBD)

Thank You!