Proposed Procedure for Addressing 75GHz Spaced Channels in 400GBASE-ZR

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802.3cw
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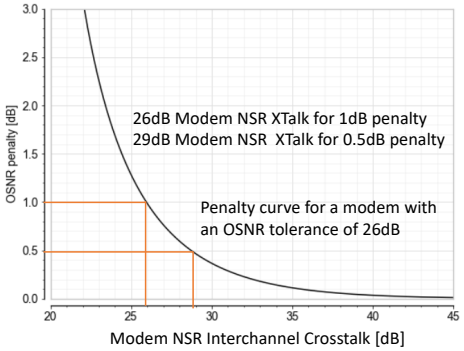
Overview

- Discuss procedure for Black Link Penalty allocations
- Focus on Crosstalk Penalty for 75GHz 400GBASE-ZR spaced applications
  - This is a followup to maniloff_3cw_01_200528
- Discuss filter and Tx spectral contributions to Interchannel Crosstalk penalty

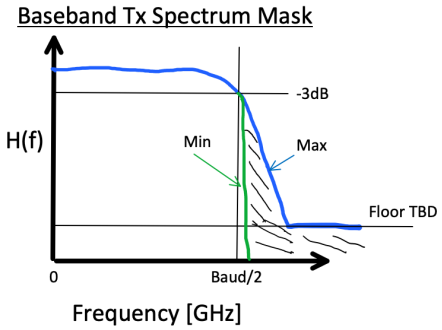
Proposed Procedure for Addressing 75GHz Spaced Channels in 400GBASE-ZR

1) Agree that OSNR penalty allocations are required in 802.3cw for the following:
   1. Inter-channel CrossTalk Penalty
   2. Intra-channel Filter Penalty
2) Agree on the accounting of the current OSNR penalty allocations to determine available margins for (1)
   1. The Black link approach for 100G coherent in ITU-T G698.2 and 802.3ct has been used to date in applications where the OSNR Penalties << OSNR Margin. This is *not* the 400GBASE-ZR use case:
      - I would advocate that we explore a 0.5dB-1dB Inter-channel CrossTalk Penalty window for viability.
      - I would advocate that we should limit the Intra-channel Filter Penalty to <0.5dB
3) Accept the Modem NSR XTalk calculation (maniloff_3cw_01_200528) as a viable framework for calculating (1.1)
   1) This calculation requires definition of the Tx Spectrum, the Mux/Demux Filter Attenuation Mask, and the assumption that the Rx Spectrum will adapt to match the Tx Spectrum.
   2) 26dB-29dB range for Modem NSR Interchannel XTalk bounds an OSNR penalty of 0.5dB-1dB.

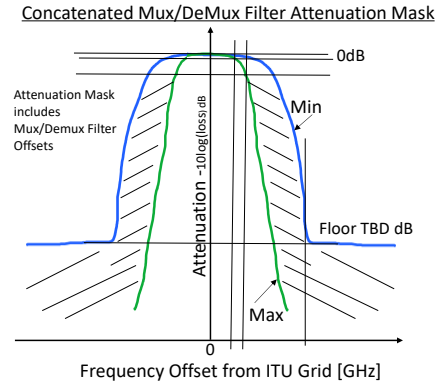


Proposed Procedure for Addressing 75GHz Spaced Channels in 400GBASE-ZR (cont)

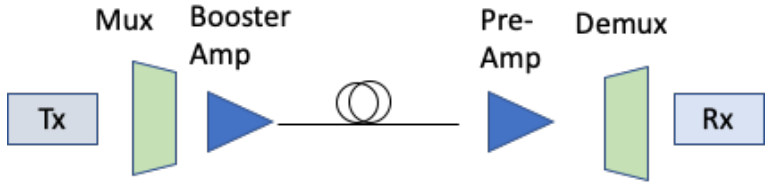
4) Agree we will define a Tx Spectrum Mask:
   1) Propose the Upper Mask limit be given as an ideal RRC curve from Baud/2 with a floor.
   2) Propose the Minimum Mask be given as an ideal RRC with Alpha=0.05.



5) Agree the Black Link Specification will define a concatenated Mux/Demux Filter Attenuation Mask:
   1) The Mask shall include the filter center offsets from the ITU grid. Absorb the current Ripple Specification?
   2) The *Minimum Attenuation Mask Limit with Floor* is bounded by (1.1), (4.1) and Tx channel power offset range
      - Current baseline specifies 4dB maximum range between transmitters
   3) The *Maximum Attenuation Mask Limit* is bounded by (1.2) and (4.1).
   4) The Tx Spectrum & Mux/Demux Filter Attenuation Mask will remove requirement for Interchannel crosstalk, which is in the FFS table in sluyski_3cw_01_200507.



100G Black Link Penalty allocations



- 100GBASE-ZR (802.3ct)
  - 16.5dB Rx OSNR tolerance
  - 3 dB Path Penalty
  - → 19.5dB OSNR required after link

Line OSNR calculation assuming a simple additive noise model:

Tx Power	-8 dBm
Tx OSNR	35 dB
Mux Loss	9.5
Booster Amp Gain	24
Booster Amp Noise Figure	6 dB
Fiber Loss	24 dB
Pre Amp Gain	23 dB
Pre Amp NF	6 dB
Rx OSNR	28.6 dB

- G.698.2 (11/2018) DP-DQPSK optical specs (Table 8-7)
  - 16dB Rx OSNR tolerance
  - 5dB Path Penalty
  - → 21dB OSNR required after link
  - ROADM applications

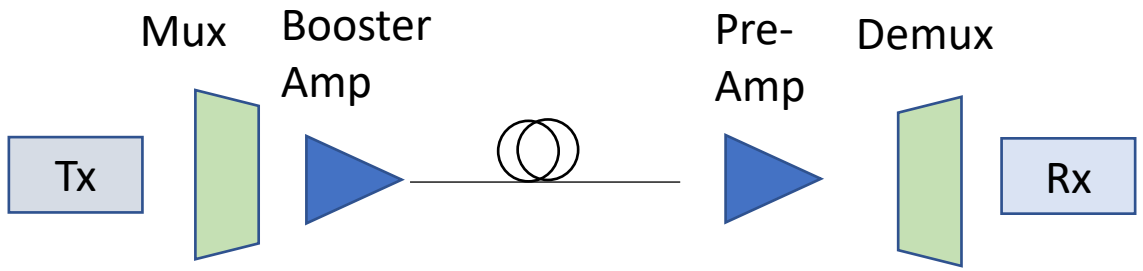
Tx Power	-5dBm
Mux Loss	5.5dB
Span Launch Power	1dBm
Span Loss	16dB
# Spans	8
# ROADMs	6
ROADM Loss	13 dB
Amp Noise Figure	6dB
Rx OSNR	25.8 dB

100G Applications have excess margin

(2) Procedure for adding OSNR penalty Allocations

- OSNR Tolerance: 26dB
  - Baseline spec, issenhuth_3cw_01_200611
- Line System Delivered OSNR?
- OIF 400ZR IA OSNR Penalty Allocations:
  - 0.5dB CD + IF XTalk
  - 0.5dB PMD
  - 0.5dB SOP
  - 1.3dB PDL
  - New Inter-channel Crosstalk
  - New Intra-channel Filter Penalty

We need to agree on a procedure to determine available margin, based on allocation for penalties using a black link methodology



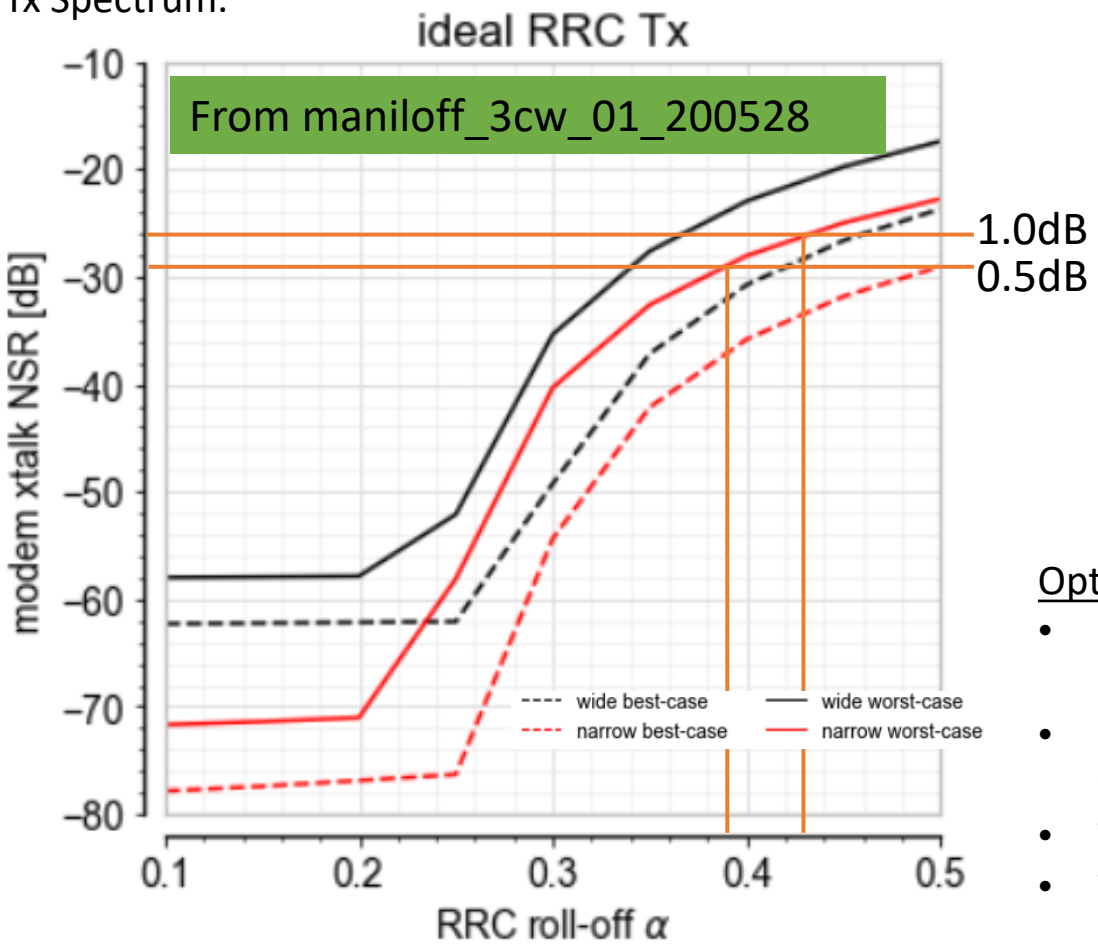
Line OSNR calculation assuming a simple additive noise model:

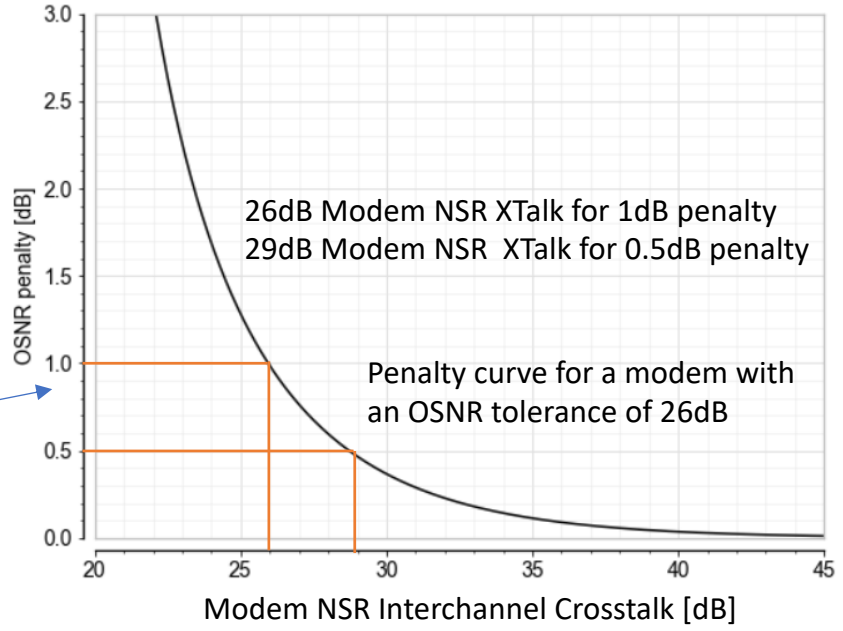
Tx Power	-10 dBm	-10 dBm
Tx OSNR	34 dB	Inf
Mux Loss	9.5	9.5
Booster Amp Gain	24	24
Booster Amp Noise Figure	6 dB	6 dB
Fiber Loss	24 dB	24 dB
Pre Amp Gain	23 dB	23 dB
Pre Amp NF	6 dB	6 dB
Rx OSNR	28.1 dB	29.4 dB

Tx Power	-10 dBm	-10 dBm
Tx OSNR	34 dB	Inf
Mux Loss	6.5 dB	6.5 dB
Booster Amp Gain	21 dB	21 dB
Booster Amp Noise Figure	6 dB	6 dB
Fiber Loss	24 dB	24 dB
Pre Amp Gain	23 dB	23 dB
Pre Amp NF	6 dB	6 dB
Rx OSNR	29 dB	30.7 dB

(3) Modem NSR XTalk Calculation-maniloff_3cw_01_200528

This calculation requires definition of the Tx Spectrum, the Mux/Demux Filter Attenuation Mask, and the assumption that the Rx Spectrum will adapt to match the Tx Spectrum.





0.39-0.43 Tx/Rx Alpha for 0.5dB-1dB Interchannel XTalk penalty with "Narrow WC" Filter in maniloff_3cw_01_200528

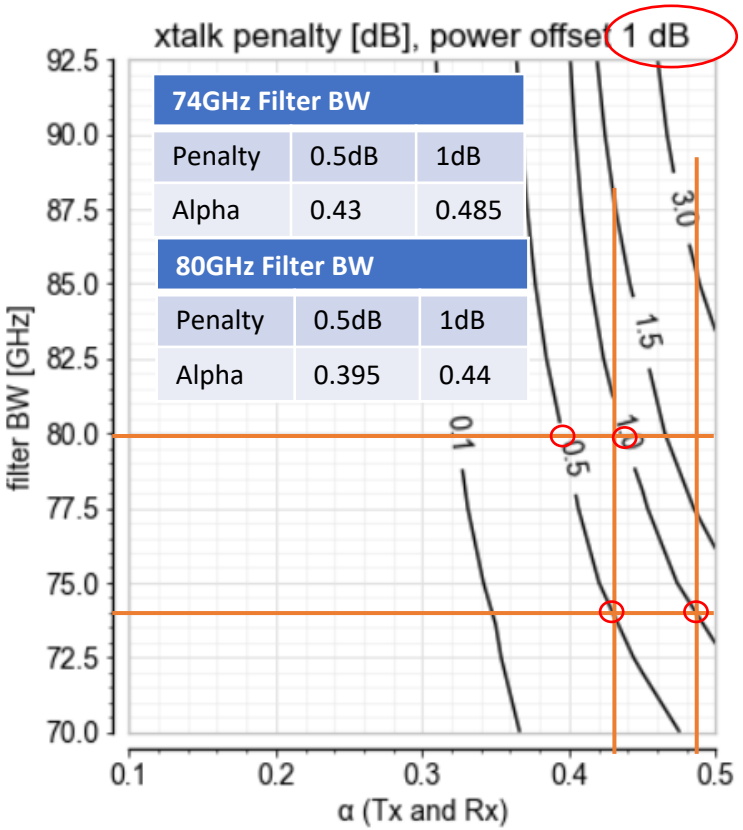
Options to Reduce XTalk and Increase Acceptable Alpha :

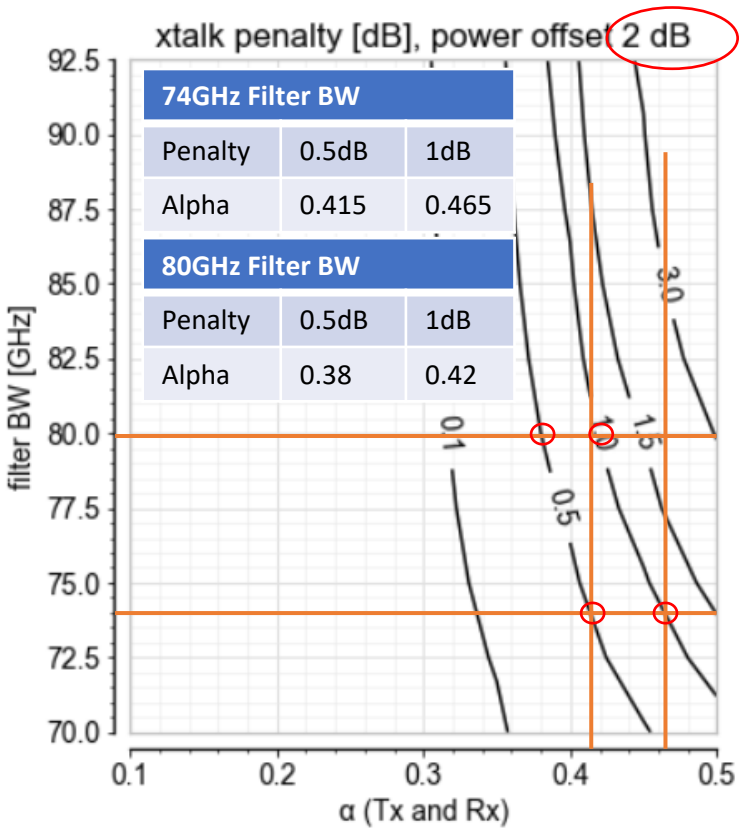
- Reduce Tx channel power offsets [currently 4dB for Tx power range specified in adopted baseline]
- Is the +/-3GHz used in these calculations sufficient for the maximum frequency offset of the Mux/Demux Filters?
- Tighten the "Narrow Filter" bandwidth.
- The +/-1.8GHz Tx/Rx laser offsets from ITU grid should not be touched

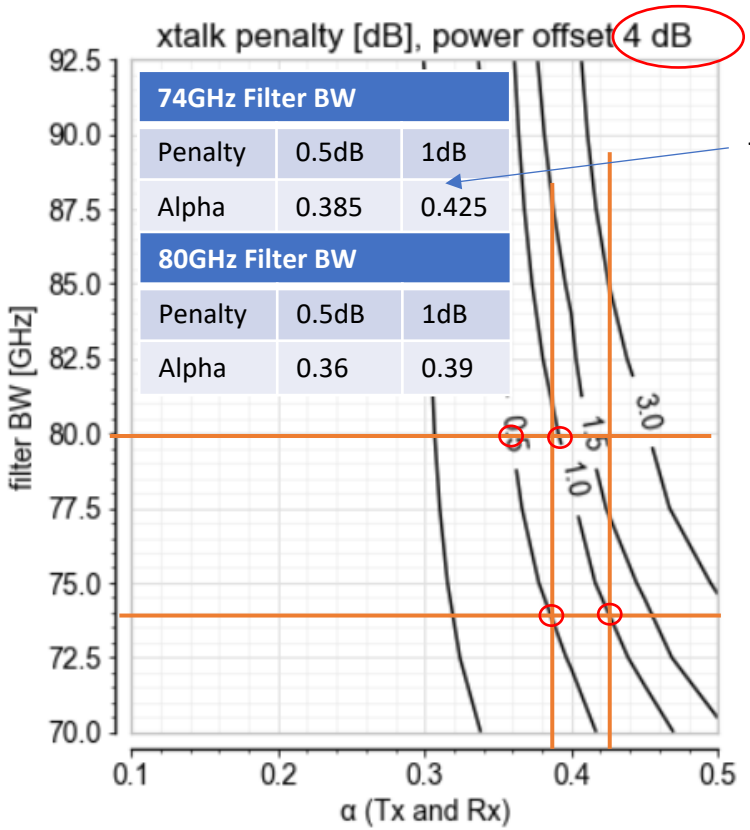
Note: Previously we defined super-gaussian filters using 20log. Moving forward we are going to align with the 10log definition used by filter manufacturers to simplify discussions. "The Narrow Filter" in maniloff_3cw_01_200528 has a 3dB bandwidth of 74GHz

(3) Modem NSR XTalk Calculation Update

- Here we show the Modem NSR Interchannel Crosstalk OSNR penalty as a function of a 3rd order super-gaussian filter BW and the ideal RRC Alpha of the Tx. The Rx filter is assumed to adapt to match the Tx filter. Modem OSNR tolerance of 26dB.
- Required OSNR penalty budget can be read from these contour plots:
  1. Tx channel power between channels should be better controlled. Contour plots are shown for Δ4dB, Δ2dB and Δ1dB nearest neighbour Tx channel power uniformity.
  2. Based on recent discussions with multiple interested companies we have increased the maximum frequency offset between the Mux/Demux Filters from +/-3GHz to +/-4GHz.
  3. The +/-1.8GHz maximum laser frequency offset from ITU grid has not been changed
- Note: Tx/Rx Alpha <=0.3 has <0.1dB penalty (negligible) for any 3rd order filter BW as concluded in maniloff_3cw_01_200528







Little change from previous result due to (2)

Summary

- We propose using this approach to specify the Tx spectrum and filters for the 400GBASE-ZR specification in 802.3cw

Thanks!