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Wireline Access Network

Preparing for DOCSIS® 4.0 Upstream

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2021 Fall Technical Forum
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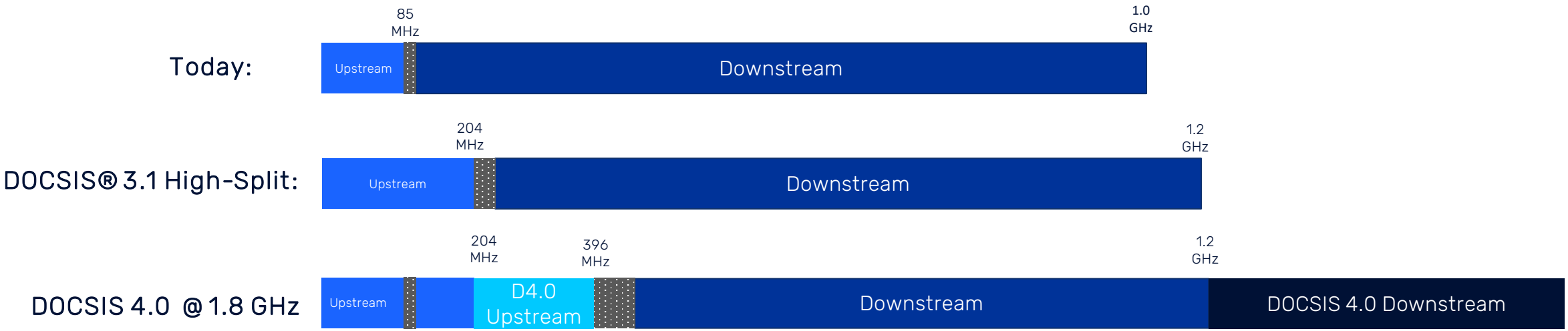
Higher Upstream Splits → Higher Capacity & Complexity



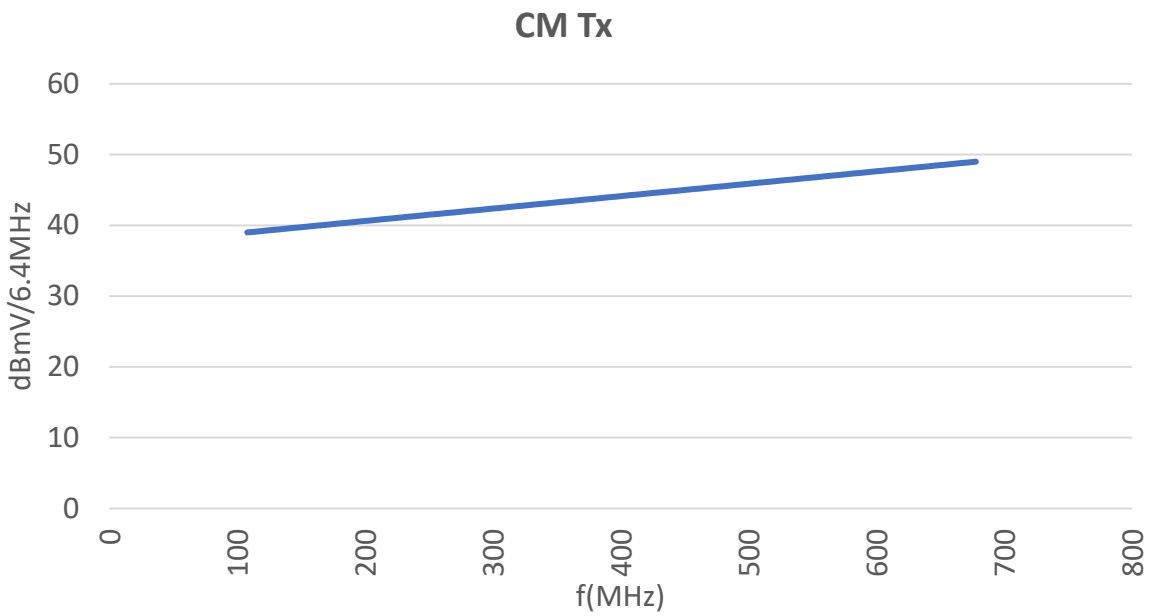
As we move to higher splits

Complexity

+

Performance Expectation

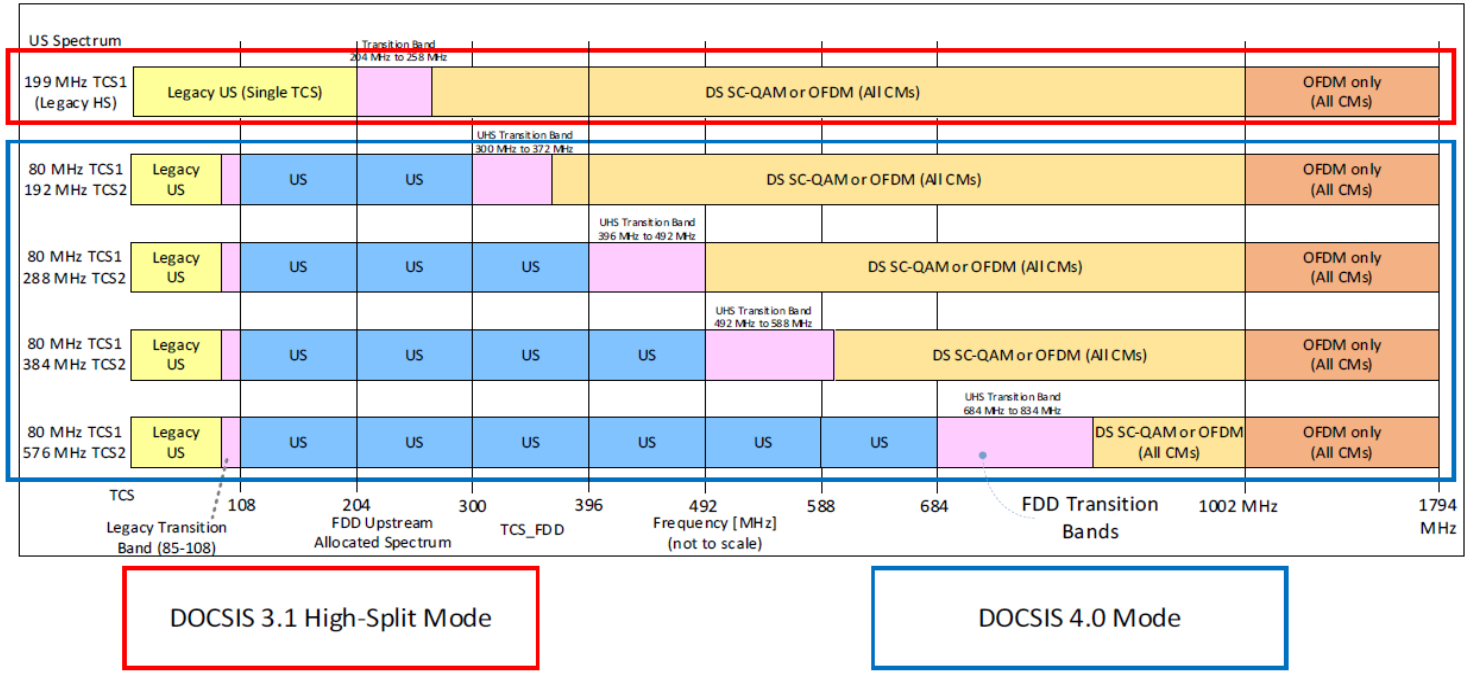
CM Tx Power /6.4MHz



Required Input Level @ Amplifier/Node Port

Return Path BW	Input Power to Return Path Amp. (dBmV/6.4MHz)
85 MHz	16
204 MHz	12
396 MHz	9
492 MHz	8

FDD Upstream Allocated Spectrum Bandwidths



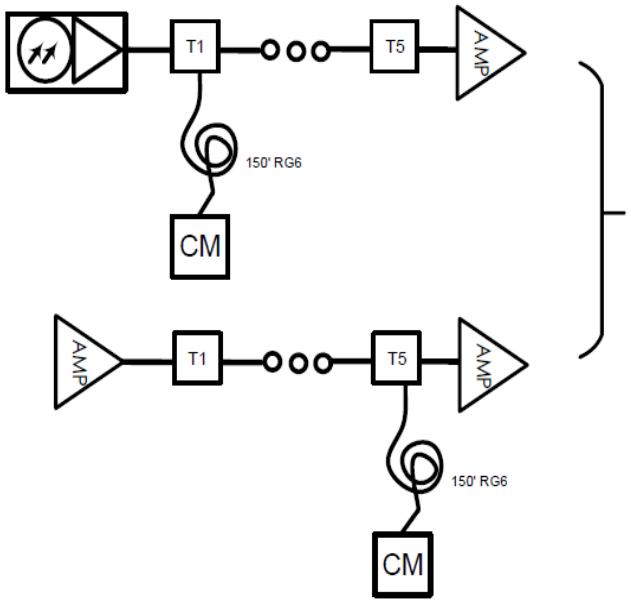
DOCSIS 3.1 High-Split Mode

DOCSIS 4.0 Mode

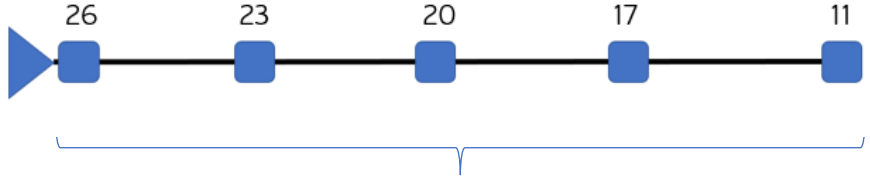
Constellation vs Power vs CNR @ Node/Amp Port

Constellation	CNR (dB)	Power Level (dBmV/6.4 MHz)
256-QAM	29.0	3
512-QAM	32.5	3
1024-QAM	35.5	3
2048-QAM	39.0	10
4096-QAM	43.0	13

Plant Model Analyzed

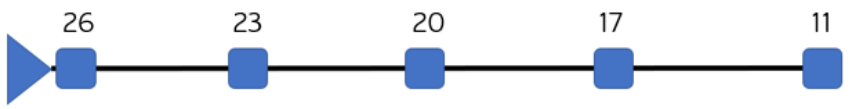


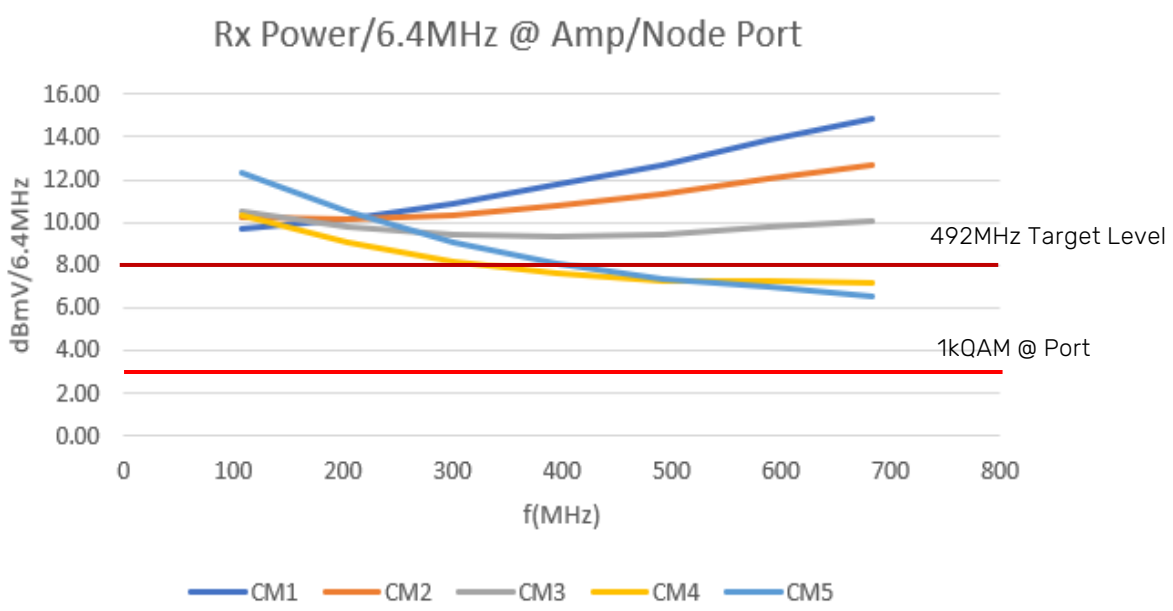
- Span Loss:
  - 750MHz:
    - Distribution: 27dB
  - 1GHz:
    - Typical Plant:
      - Distribution: 32dB
    - Stretched Plant:
      - Distribution: 35dB



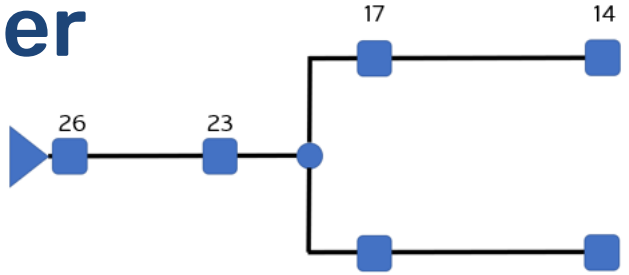
35 dB of Span loss @ 1GHz

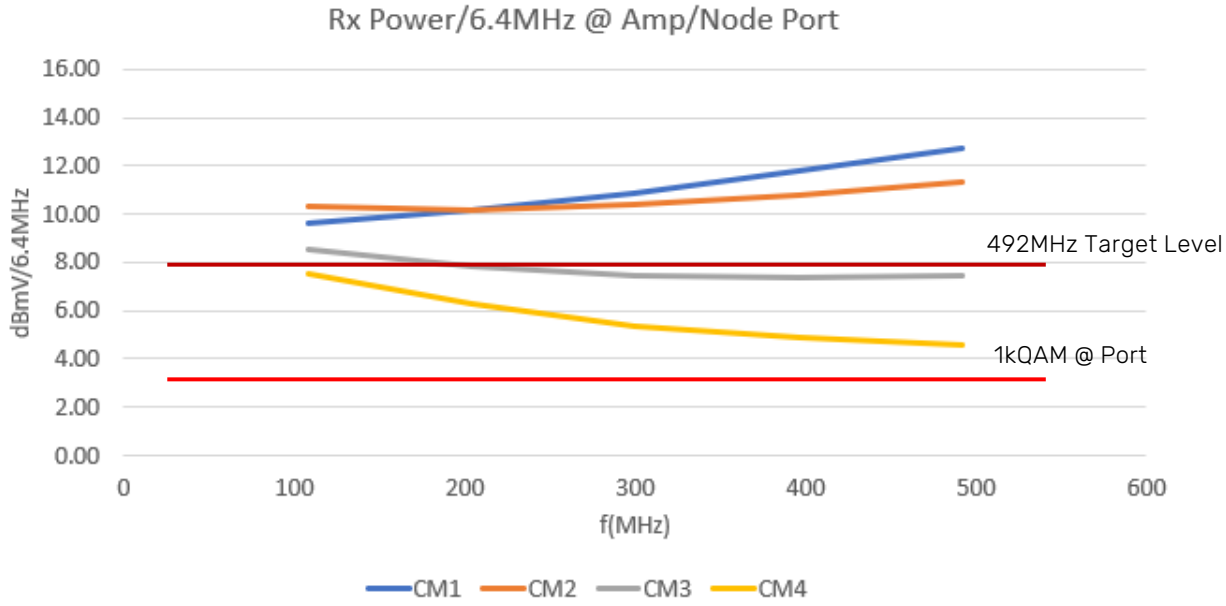
Base Plant Model



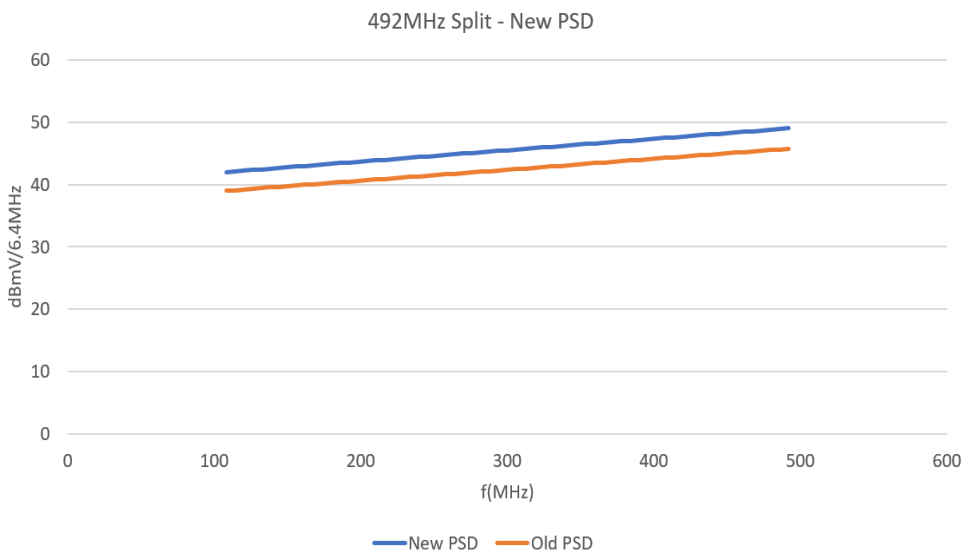


Plant Model with Two-Way Splitter

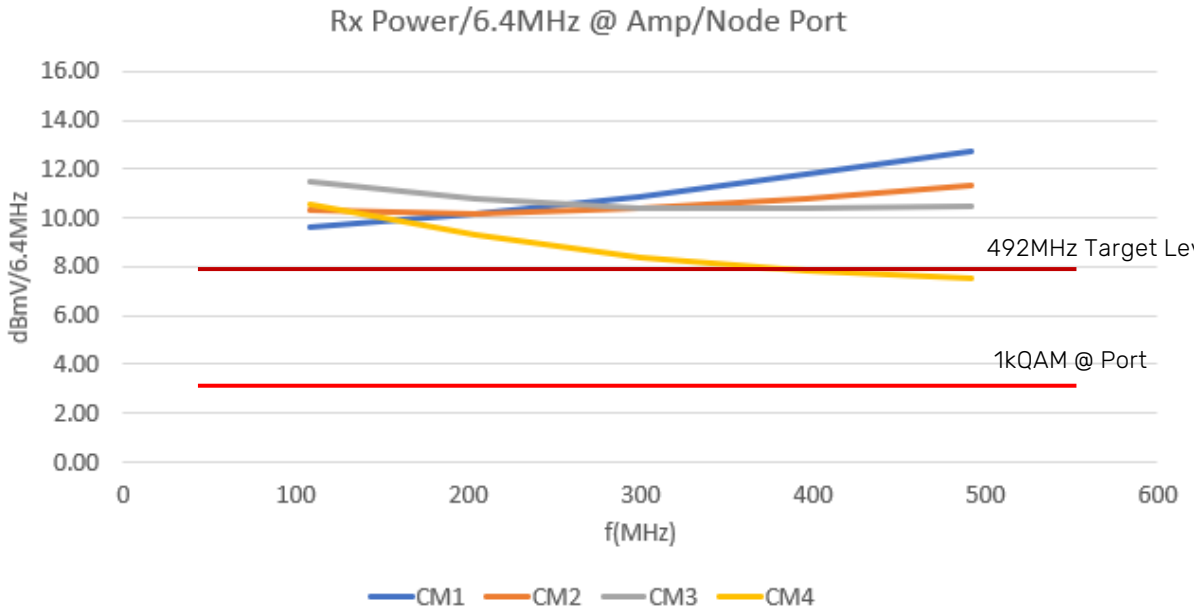




Boosting CM Tx



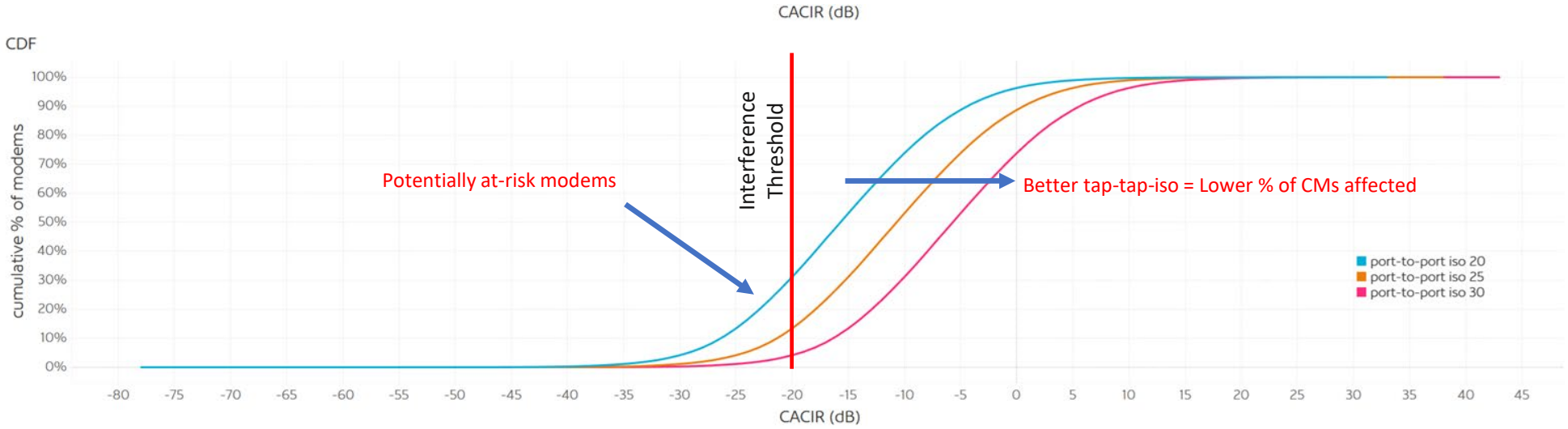
Plant Model with Two-Way Splitter



Upstream performance will not be power limited for most cases.

Higher CM Tx Powers Must be Balanced

- Higher transmit power from the CMs can increase the risk of neighbour interference.



Reference: Optimizing the 10G Transition to Full-Duplex DOCSIS® 4.0, Richard S Prodan, Comcast – with proposed changes to the methodology

Noise Funneling

All Ports Funneled

Total Number of Amplifiers	CTN	CIN	Source MER (38 dB)	Source MER (40 dB)	Source MER (47 dB)
16	45.36	49.98	37.04	38.56	42.28
32	42.35	48.22	36.35	37.61	40.3
44	40.97	47.55	35.92	37.04	39.3
56	39.92	46.97	35.52	36.54	38.48
68	39.07	46.00	35.12	36.04	37.73

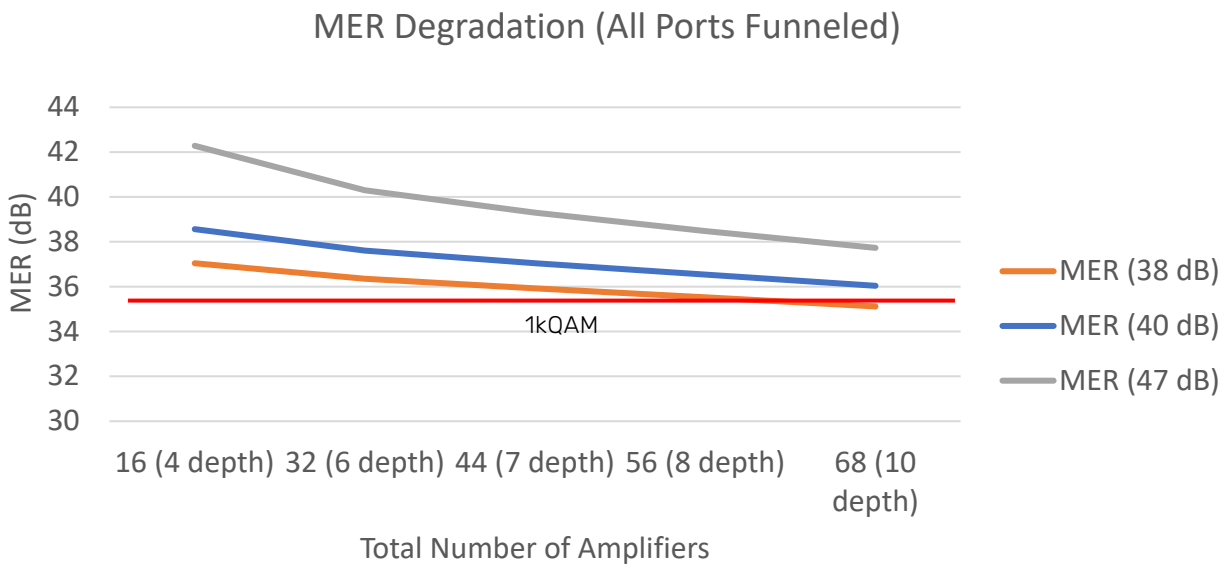
Single Node Leg

Total Amps in Series	CTN	CIN	Source MER (38 dB)	Source MER (40 dB)	Source MER (47 dB)
4	51.38	49.98	37.55	39.31	44.29
6	48.37	48.22	37.26	38.87	43.05
7	46.99	47.55	37.08	38.61	42.4
8	45.94	46.97	36.9	38.37	41.84
10	45.1	46.00	36.68	38.07	41.19

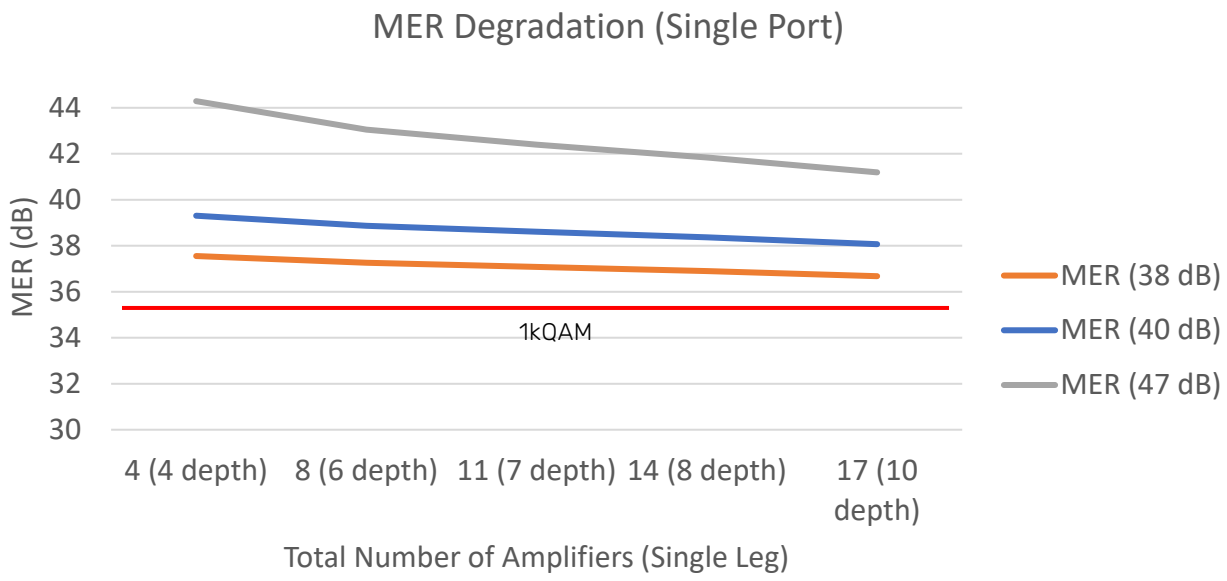
- Amplifier NF: 6 dB
- Amplifier CIN: 56 dB
- Input level to each amplifier in the return path: 6 dB flat across the spectrum
- Number of ports utilized in the node: 4
- CTN: All the amplifiers on either the entire node or each leg that would contribute to signal degradation
- CIN: Only the amplifiers in series on each leg of the node that would contribute to signal degradation

Noise Funneling

All Ports Funneled



Single Node Leg



Conclusions

- DOCSIS 4.0 upstream is very likely to work with high performance for a majority of cases
  - The biggest areas of concern are:
    - High flat loss areas that the CM will have to 'overcompensate' for in the upstream
    - Higher transmit powers may increase the likelihood of neighbour interference
  - Starting/Source MER from the modems in the return is the highest indicator of performance (assuming no plant impairments)
    - Thermal noise and distortion funneling from amplifiers can degrade the performance, but not by a large amount
      - Isolating node ports can be very important for limiting noise to a single port
      - High transmit powers should be balanced with neighbour interference

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Thank You!

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