OPTICAL POWER AND OSNR COMPARISON AND PROPOSAL FOR 100G OBJECTIVE

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MEETING CABLE MSO REQUIREMENTS

- Cable MSO application was a key part of the Broad Market Potential for 100 GbE over 80 km objective
  - Therefore, ensuring this specification supports that application remains critical

- Motivation for multiple previous contributions including:
  - CableLabs PHYv1.0 spec (http://www.ieee802.org/3/cn/public/19_01/P2PCO-SP-PHYv1.0-I01-180629.pdf)
  - Baseline Proposal for 100G/80km Objective (http://www.ieee802.org/3/cn/public/19_01/schmitt_3cn_01b_0119.pdf)
  - Cable Operator Inputs for 100G+ Beyond 10k (http://www.ieee802.org/3/B10K/public/18_05/schmitt_b10k_01a_0518.pdf)

FOCUS ON OPTICAL POWER AND OSNR

- This presentation focuses on a key aspect of that:
  - Optical Power and OSNR for the transmitter and receiver

- These parameters will determine the link budget or "reach" for a given system
  - Critical for determining if it will be useful for Cable MSO application

- This contribution identifies targets for MSO application, compares how various existing specifications compare to these targets, and proposes baseline for TF consideration in this area

CABLE MSO PLANT SURVEY DATA
(PREVIOUSLY CONTRIBUTED: HTTP://WWW.IEEE802.ORG/3/B10K/PUBLIC/18_05/SCHMITT_B10K_01A_0518.PDF)

- Surveyed optical link distances
  - <40km: 88%
  - <80km: 98%

- Number of optical channels
  - 1 channel: 50%
  - >1 channel (WDM): 50% (trending upwards)

- Optical amplifier location
  - When present, primarily in "hub" location only (amplifier only on one end of link)

RESULTING CABLELABS SPECIFICATION OBJECTIVES

- Reach of at least 40 km without optical amplification when deployed with 40-channel DWDM mux/de-mux (figure on left, Case A)

- Reach of at least 80 km with optical amplification at hub site only when deployed with 40-channel DWDM mux/de-mux (figure on right, Case B)
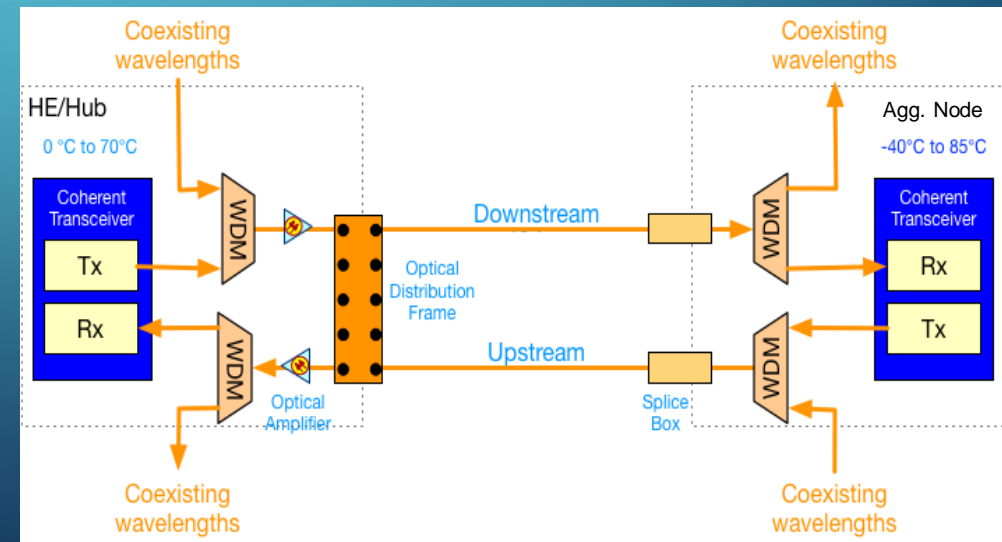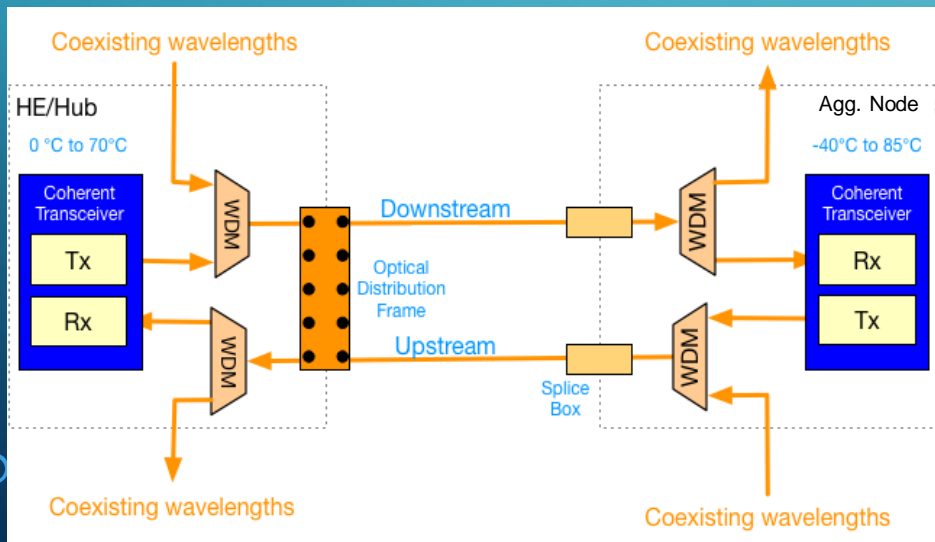
OPTICAL POWER AND OSNR COMPARISON

- The following specifications defined these parameters for 100G DWDM using coherent optics:
  - ITU, G.698.2 (11/2018)
  - CableLabs, P2PCO-SP-PHYv1.0
  - OpenROADM, specification ver 3.0
- This table compares those values
  - Note: CableLabs values adjusted for "End of Life" for equal comparison

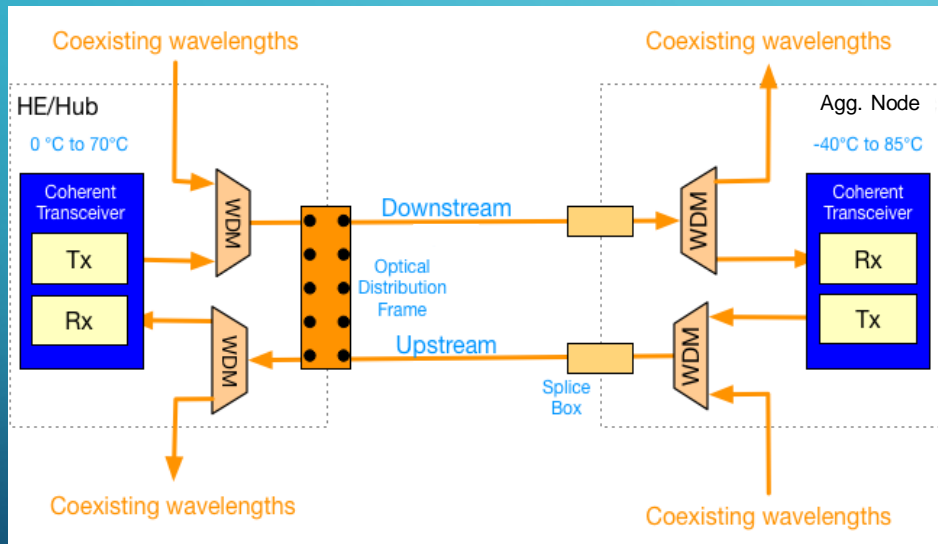|	G.698.2	PHYv1.0	OpenROADM
Minimum Tx Output Power	-8 dBm	-6.5 dBm	-5 dBm
Minimum Tx OSNR (193.6)	NA	35 dB	33 dB
Minimum Rx Input Power	-18 dBm	-30 dBm @35 dB OSNR	-22 dBm
Rx OSNR Tolerance (193.6)	19 dB	15.5 dB @-10 dBm Rx	17 dB

COMPARISON ITEMS OF NOTE

- Significant differences in receiver requirements
  - OSNR Tolerance and Minimum Input Power
- Likely related to two factors:
  - CableLabs requirements define "corners" for power and OSNR, and do not apply across entire range
  - G.698.2 and OpenROADM may include amplifiers at both ends of link

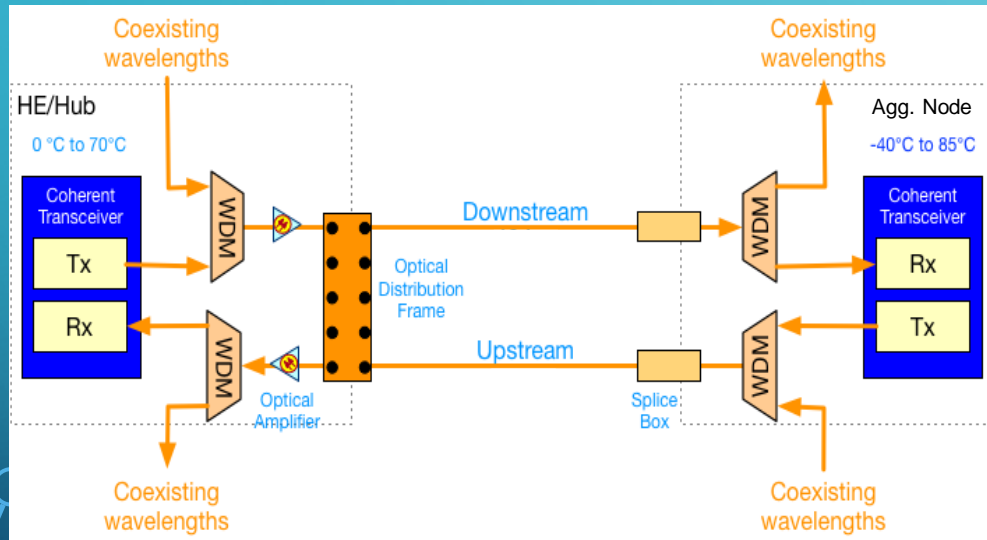|	G.698.2	PHYv1.0	OpenROADM
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Rx OSNR Tolerance (193.6)	19 dB	15.5 dB @-10 dBm Rx	17 dB

REACH CALCULATIONS

- The following slides estimates the "reach" that can be achieved for both Case A (Power Limited: DWDM, no amplifier) and Case B (OSNR Limited: DWDM, with amplifier)
    - Case A (power limited case) run for all three specifications
    - Case B (OSNR limited case) only run for CableLabs specifications thus far (based on available data), and show OSNR margin @ 80km under defined conditions

- Some details to be aware of:
    - A link impairment of 1.7 dB was assumed as a reasonable case (not worst case); no additional margin was included for Power Limited case
    - Optical equipment includes two 40-channel muxes (5 dB each) and one distribution frame (1 dB)
    - Numbers are all End of Life (EoL)
    - Fiber loss of 0.25 dB/km was used to account for splices, etc.
    - Case B assumes an amplifier that brings the Rx power up to the CableLabs spec defined value for receiver OSNR tolerance (-10 dBm)

CASE A: DWDM, NO OPTICAL AMPLIFIER (POWER LIMITED)

	G.698.2	PHYv1.0	OpenROADM
Minimum Tx Output Power (dBm)	-8	-6.5	-5
Link Impairments (dB)	1.7	1.7	1.7
Optical Equipment Loss (dB)	11	11	11
Rx Power w/Loss (dBm)	-20.7	-19.2	-17.7
Minimum Rx Input Power (dBm)	-18	-30	-22
Min Link Budget (dB)	NP	10.8	4.3
Reach (km)	NP	43.2	17.2

CASE B: DWDM, WITH OPTICAL AMPLIFIER (OSNR LIMITED, UPSTREAM DIRECTION)

Results for "PHYv1.0" column from CableLabs P2PCO-SP-ARCH-I02-190311 specification

	G.698.2	PHYv1.0	OpenROADM
Minimum Tx Output Power (dBm)	-8	-6.5	-5
Minimum Tx OSNR (dB)	NA	35	33
Rx OSNR Tolerance (dB)	19	15.5	17
Amplified Rx Power @ upstream receiver	TBD	-10	TBD
OSNR Impairments (dB)	1.7	1.7	1.7
Rx OSNR Tolerance w/Impairments (dB)	20.7	17.2	18.7
Reach (km)	TBD	80+	TBD
Calculated Rx OSNR @ 80km (dB)	TBD	19.3	TBD
Rx OSNR Margin (dB)	TBD	2.1	TBD

CONCLUSION

- The Cable MSO application is a significant piece of the broad market potential for the 100G objective of 802.3ct
  - Ensuring that our solution for 100G addresses this application is important for maintaining that broad market potential

- Optical power and OSNR requirements are a key piece of this
  - Cable MSOs have some network requirements that differ slightly from some of the assumptions made by other specifications/standards and impact these requirements
  - As a result, optical power and OSNR requirements in those specifications may not support cable MSO application without modification

PROPOSALS

1. Define separate OSNR and receive power requirements for amplified and unamplified scenarios as used in the CableLabs specifications, and as suggested in http://www.ieee802.org/3/ct/public/19_03/stassar_3ct_01_0319.pdf

2. Adopt values that ensure we can meet our 80km objective for 100G with amplifiers at only one end of the link

3. Adopt reasonable values for unamplified links without creating a new objective or separate PMD based on device capabilities

4. Consider the values in the CableLabs specification as a starting point for these values, with modifications based on TF feedback as needed

THANKS!