Baseline considerations for 100G and 400G DWDM objectives

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Introduction

This presentation provides considerations and associated proposals towards optical baseline specifications for the following objectives:

- Provide a physical layer specification supporting 100 Gb/s operation on a single wavelength capable of at least 80 km over a DWDM system.
- Provide a physical layer specification supporting 400 Gb/s operation on a single wavelength capable of at least 80 km over a DWDM system.

At the previous meeting in Long Beach, January 2019, several related strawpolls and motions were taken, which are reproduced on the next slide.

Motions and Strawpolls at Long Beach Meeting

- **Motion #7: Move to adopt DP-DQPSK modulation format for the 100 GbE 80km objective**
  - **Results (all): Yes: 46, No: 0, Abstain: 10**
- **Straw poll #1: I would support adopting 100 GHz channel spacing for 400GBASE-ZR**
  - **Yes: 43, No: 0, Need more info: 0, Abstain: 6**
- **Straw poll #4: I support the specification methodology used for 100 Gb/s coherent optics specified in G.698.2.**
  - **Yes: 18, No: 0, Need more info: 2, Abstain: 3**
- **Straw poll #5: I support the development of 100GBASE-ZR / 400GBASE-ZR that defines operation over both amplified and (shorter reach) unamplified DWDM systems.**
  - **Yes: 24, No: 0, Need more info: 0, Abstain: 0**

Approach for 100G specification

- **In view of the results of Straw poll #4,**
  - **“I support the specification methodology used for 100 Gb/s coherent optics specified in G.698.2.” with results, Yes: 18, No: 0, Need more info: 2, Abstain: 3,**
- **We propose to use the list of parameters defined in G.698.2 (11/2018), https://www.itu.int/rec/T-REC-G.698.2-201811-I as a starting point**
- **Some parameter names may need modified wording, for instance referring to TP2 instead of S_S and TP3 instead of R_S, to be consistent with IEEE 802.3 naming conventions**
- **In view of the results on Straw poll #5, a row for Transmitter OSNR has been added to the table for the Tx parameters, shown in Italic font and a row for Minimum mean input power [unamplified] has been added to the Rx parameters.**

Optical specification methodology principles

- Optical Transmitter is Black Box. Inside not specified. Implementation freedom
- At TP2 transmitter output signal is specified via (measurable) parameters and values
- The (black) link is characterized by its transfer characteristics as TP2 to TP3.
- Only limited link design elements are specified like maximum discrete reflectance.
- The optical signal at TP3 is created via “combining” optical signal at TP2 with link transfer characteristics TP2 to TP3.
- Optical receiver is also Black Box. Inside not specified. Implementation freedom.
- The only Receiver requirement: provide the specified Receiver performance under worst case receiver input optical signal at TP3.
- Example of non appropriate receiver parameter: receiver bandwidth.

Parameters for 100GBASE-ZR transmit characteristics

Parameter Name	Units
Maximum mean channel output power	dBm
Minimum mean channel output power	dBm
Minimum central frequency	THz
Maximum central frequency	THz
Maximum spectral excursion	GHz
Minimum side mode suppression ratio	dB
Maximum laser linewidth	kHz
Maximum offset between the carrier and the nominal central frequency	GHz
Maximum power difference between polarizations	dB
Maximum skew between the two polarizations	ps
Maximum error vector magnitude	%
Maximum I-Q offset	dB
Minimum Transmitter OSNR(193.6)	dB

Parameters for 100GBASE-ZR receive characteristics

Parameter Name	Units
Maximum mean input power	dBm
Minimum mean input power [amplified]	dBm
Minimum mean input power [unamplified]	dBm
Minimum OSNR(193.6)	dB (0.1 nm)
Receiver OSNR tolerance(193.6)	dB (0.1 nm)
Maximum reflectance of receiver	dB

Parameters for 100GBASE-ZR black link characteristics

Parameter Name	Units
Maximum ripple	dB
Maximum (residual) chromatic dispersion	ps/nm
Minimum (residual) chromatic dispersion	ps/nm
Minimum optical return loss at S_S	dB
Maximum discrete reflectance between S_S and R_S	dB
Maximum differential group delay	ps
Maximum polarization dependent loss	dB
Maximum polarization rotation speed	krad/s
Maximum inter-channel crosstalk at R_S	dB
Maximum interferometric crosstalk at R_S	dB
Maximum optical path OSNR penalty	dB

Parameter values for 100GBASE-ZR

- **Assuming sufficient support for the proposed parameters for 100GBASE-ZR, we propose to use the following approach for defining the associated parameter values:**
  - Add 2 (or more) columns for values.
  - For the first column we propose to use the values for the DW100U-8A2(C)F application code in Recommendation ITU-T G.698.2 Table 8-8, assuming agreement on 100 GHz channel spacing.
  - For the second column we would like to consider alternative parameter values from other sources, as in http://www.ieee802.org/3/cn/public/19_01/schmitt_3cn_01b_0119.pdf, as long as they are defined in End of Life conditions.
  - Discuss towards a single (preferred) value and use the Task Force review process to optimize.
- As a note, parameters for the 100 Gb/s optical interface specified by OpenROADM have not been taken into account because those are specified for applications over significantly longer distances than the 80 km which P802.3ct is considering.

100GBASE-ZR transmit characteristics

Parameter Name	Units	G.698.2 Value	CL PHYv1.0
Maximum mean channel output power	dBm	–3	+7
Minimum mean channel output power	dBm	–8	-6.5
Minimum central frequency	THz	191.5	191.3
Maximum central frequency	THz	196.2	196.2
Maximum spectral excursion	GHz	±15	NA
Minimum side mode suppression ratio	dB	30	NA
Maximum laser linewidth	kHz	500	1000
Maximum offset between the carrier and the nominal central frequency	GHz	1.8	1.8
Maximum power difference between polarizations	dB	1.5	1.5
Maximum skew between the two polarizations	ps	10	6
Maximum error vector magnitude	%	23	NA
Maximum I-Q offset	dB	–25	NA
Minimum Transmitter OSNR(193.6)	dB	NA	35

100GBASE-ZR receive characteristics

Parameter Name	Units	G.698.2 Value	CL PHYv1.0
Maximum mean input power	dBm	0	NA
Minimum mean input power [amplified]	dBm	–18	–10
Minimum mean input power [unamplified]	dBm	NA	–30
Minimum OSNR(193.6) [amplified]	dB (0.1 nm)	24	18.5 (?)
Minimum OSNR(193.6) [unamplified]	dB (0.1 nm)	NA	35
Receiver OSNR tolerance(193.6)	dB (0.1 nm)	19	15.5 (?)
Maximum reflectance of receiver	dB	–27	-20

100GBASE-ZR black link characteristics

Parameter Name	Units	G.698.2 Value	CL PHYv1.0
Maximum ripple	dB	2.5	NA
Maximum (residual) chromatic dispersion	ps/nm	2400	2400
Minimum (residual) chromatic dispersion	ps/nm	–200	NA
Minimum optical return loss at S_S	dB	24	25
Maximum discrete reflectance between S_S and R_S	dB	–27	-20
Maximum differential group delay	ps	20	20
Maximum polarization dependent loss	dB	1.5	0.5
Maximum polarization rotation speed	krad/s	50	50
Maximum inter-channel crosstalk at R_S	dB	–16	NA
Maximum interferometric crosstalk at R_S	dB	–25	NA
Maximum optical path OSNR penalty	dB	5	3 (?)

Approach for 400G specification

- **A first 400G baseline proposal has been made in http://www.ieee802.org/3/ct/public/adhoc/19_0221/lyubomirsky_3ct_01_190221.pdf**
- **This was extensively discussed at the P802.3ct ad hoc call on 21 February 2019.**
- **We very much support the intent to reuse as much as possible from the work that the OIF has done in its 400ZR project.**
- **We however also feel that we need a complete approach similar to the one for 100G**
- **We therefore propose to use the same parameter tables for 400G as suggested for 100G on slides 6 – 8 of this presentation,**
- **Populate the tables with parameter values identical to or consistent with the latest version of OIF's draft specification for 400ZR**
- **Label the value TBD for those parameters for which a value is not yet available from other standards organizations and/or other work outside of IEEE 802.3.**

400GBASE-ZR transmit characteristics

Parameter Name	Units	OIF Value	Alt Value
Maximum mean channel output power	dBm	–6	
Minimum mean channel output power	dBm	–10	
Minimum central frequency	THz	191.3/191.4	191.5
Maximum central frequency	THz	196.1	
Maximum spectral excursion	GHz	TBD	
Minimum side mode suppression ratio	dB	TBD	
Maximum laser linewidth	kHz	500	
Maximum offset between the carrier and the nominal central frequency	GHz	1.8	
Maximum power difference between polarizations	dB	1.5	
Maximum skew between the two polarizations	ps	5	
Maximum error vector magnitude	%	TBD	
Maximum I-Q offset	dB	–26	
Minimum Transmitter OSNR(193.6)	dB	37	

400GBASE-ZR receive characteristics

Parameter Name	Units	OIF Value	Alt Value
Maximum mean input power	dBm	0	
Minimum mean input power [amplified]	dBm	–12	
Minimum mean input power [unamplified]	dBm	–20	TBD
Minimum OSNR(193.6) [amplified]	dB (0.1 nm)	TBD	
Minimum OSNR(193.6) [unamplified]	dB (0.1 nm)	37	
Receiver OSNR tolerance(193.6)	dB (0.1 nm)	26	
Maximum reflectance of receiver	dB	–20	–27

400GBASE-ZR black link characteristics

Parameter Name	Units	OIF Value	Alt Value
Maximum ripple	dB	TBD	
Maximum (residual) chromatic dispersion	ps/nm	2400	1600 to 2400
Minimum (residual) chromatic dispersion	ps/nm		–200
Minimum optical return loss at S_S	dB	24	
Maximum discrete reflectance between S_S and R_S	dB		–27
Maximum differential group delay	ps	30	
Maximum polarization dependent loss	dB	3.5	1.5
Maximum polarization rotation speed	krad/s	50	
Maximum inter-channel crosstalk at R_S	dB	TBD	
Maximum interferometric crosstalk at R_S	dB	TBD	
Maximum optical path OSNR penalty	dB	0.5	TBD

Thanks!