Compliance Methodology for 400GBase-ZR Transceivers in 75GHz-spaced DWDM Links

Winston Way, NeoPhotonics

Tom Williams, Acacia

Mike Sluyski, Acacia

Eric Maniloff, Ciena

802.3cw

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Supporters

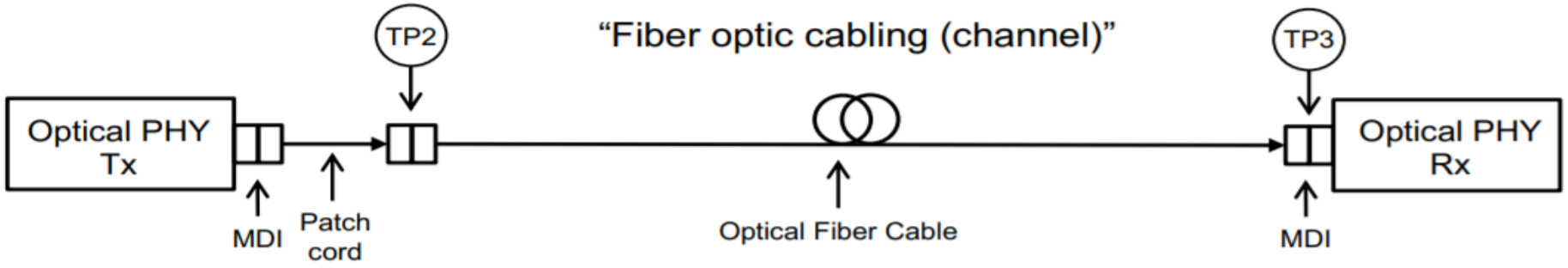
- Binbin Guan, Microsoft
- Yawei Yin, Microsoft
- Atul Srivastava, NEL
- Mark Nowell, Cisco
- Gary Nicholl, Cisco
- Paul Brooks, Viavi Solutions
- Saraj Elahmadi, IPG Photonics
- Fred Heismann, IPG Photonics
- Hideki Isono, FOC

OUTLINE

- Traditional and 802.3ct Optical Ethernet PHY link parameters
- Comparing different compliance methodologies
- Add 75GHz-spaced DWDM TX and Link Parameters for 802.3cw

Traditional Optical Ether PHY Link

- Channel parameters: optical loss, dispersion, reflectance
- Transmitter parameters: Output power, ER, OMA, TDECQ
- Receiver parameters: Sensitivity (OMA), stressed eyes
- Compliance methodology: Compliance testing defined for transmitter and receiver, not the channel. Network operator is responsible for ensuring channel is compliant

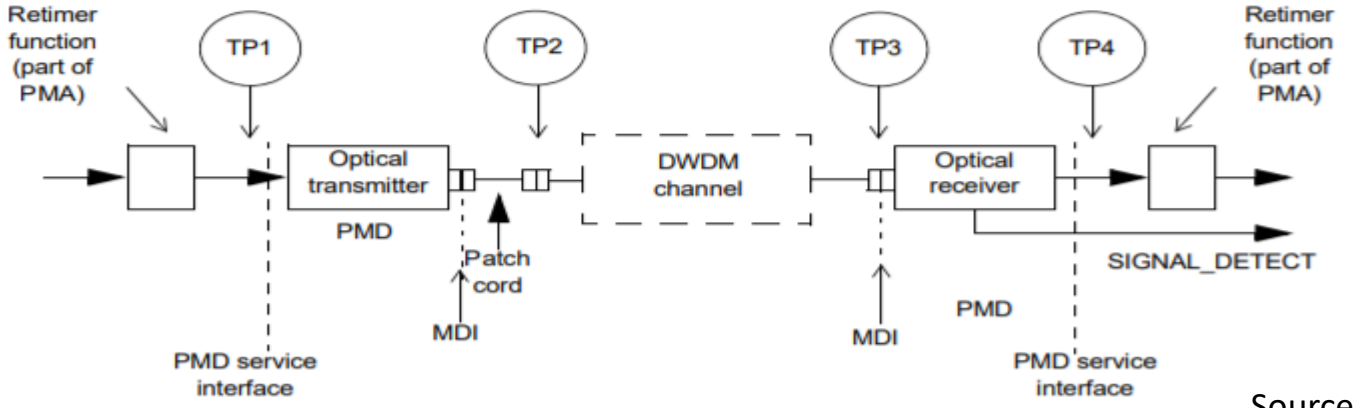


For clarity, only one direction of transmission is shown

Ref: 802.3cd D2.2 Clause 139

Coherent DWDM Ethernet PHY Link *(802.3ct)*

- Channel parameters: OSNR penalty (max optical path penalty 3dB)
  - Inter-channel crosstalk and mux/demux filtering penalty were insignificant for 802.3ct 100GHz-spaced 27.9525 GBd signals
  - Other parameters such CD, PMD, PDL, SOP, etc., have been defined
- Transmitter parameters: Transmitter OSNR/SMSR, laser frequency offset, max freq excursion
  - Other parameters such IQ skew, IQ imbalance, quadrature error, and IQ offset have also been defined
- Receiver parameters: Received OSNR at a pre-FEC BER threshold, received optical power range
- Compliance methodology: ***Single*** channel compliant to the above three sets of parameters



Source: 802.3ct

What More to be Defined in 802.3cw in reference to 802.3ct?

- Key difference: Inter-channel crosstalk can be significant for 75GHz-spaced 59.84 GBd signals. Need to define the OSNR penalty due to the inter-channel crosstalk and mux/demux filtering specifically.
- Test Methodology: Three consecutive 75GHz-spaced channels must be tested simultaneously, with the center channel as the DUT
- Define TX spectral mask? (√)
- Define reference receiver?
- Define 64-ch 75GHz-spaced DWDM MUX and DEMUX? (√)

Comparing Different Compliance Methodologies

Reference	IEEE contribution	TX (mask)	RX	MUX/DEMUX
1	Maniloff_3cw_01-200910	RRC α=0.39~0.43	Matched to TX	Vaguely defined
2	Zhang_3cw_01a_201116	Undefined	Sub-optimal reference receiver defined as 34GHz 5th-order Butterworth based on TX RRC α=0.4	Defined
3	This contribution	RRC α=0.4	Sub-optimal arbitrary shape, but must meet OSNR penalty<1dB	Defined

Comments on Ref. 1: (a) Ideal matched TX/RX filter case cannot always be met, due to sub-optimal analog front-end or limited transmitter/receiver over-sampling rate; (b) Mux/Demux specs vaguely defined, leaving room to different MUX/DEMUX implementation in different systems, causing inter-op uncertainties.

Comments on Ref. 2: (a) Sub-optimal receiver is based on a pre-defined transmitter spectral shape, in conflict with the assumption that a transmitter spectrum is undefined; (b) given a reference receiver, if the transmitter does not pass the performance criteria, one cannot tell it is due to the transmitter itself or its two neighbor aggressors.

Add 75GHz-spaced DWDM TX and Link Parameters for 802.3cw

Transmitter Specifications	
TX spectral mask upper limit at zero frequency shift[1] (0dB at center without considering any leakage carrier)	-3dB @ 30GHz, -10dB @ 37GHz, and -15dB @39.5GHz (3 discrete points on RRC alpha=0.4); <-20dB floor
TX spectral mask lower limit at zero frequency shift[2]	-9dB from baud rate/2 out to the intercept of the RRC α=0.05 curve and then follow the RRC α= 0.05 curve
TX output power stability[3]	≤ +/- 0.5dB
Adjustable TX output power range	≥ 5dB
MUX and DEMUX specifications	
Filter shape	3rd-order Super-Gaussian
3dB bandwidth	70 ~ 76GHz
Insertion loss	≤ 6.5 dB
Port-to-port insertion loss variation	≤ 1.5dB
Non-adjacent channel isolation	≥ 20dB
Receiver Specifications	
ROSNR after back-to-back MUX and DEMUX	≤ 27dB[4]

To control the channel-to-channel optical power variation[3]

[1]Sluyski_cw_01a_200423
[2]Maniloff_cw_01_200910
[3]Power adjustment is included to allow channel equalization. The method of equalization is not specified.
[4]Back-to-back OSNR without MUX and DEMUX is ≤ 26dB. Note this may be included in path penalty.