Considerations of BR40 wavelength plan

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IEEE P802.3dk Greater than 50 Gb/s Bidirectional Optical Access PHYs Task Force

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Introduction

- As discussed in previous meeting, when making decisions regarding the wavelength plan for BR10, BR20, and BR40, the most important factor to consider is a chromatic dispersion-limited wavelength band at 100Gb/s signal rate (PAM4).
- At 100 Gb/s signal rate per wavelength, the transmission distances of BR10 and BR20 are relatively short, which means a wide range wavelength band available. Therefore, a channel spacing of 20 nm (CWDM) or 800 GHz (LAN-WDM) has been discussed as a possible solution for BR10 or BR20.
- For BR40, the chromatic dispersion-limited wavelength band is relatively narrow when using a 100 Gb/s signal rate, which results in a tight channel spacing such as DWDM channel spacing.
- So, using DWDM channel spacing can present significant challenges when implementing 100Gb/s BOSA

100Gb/s based BR20 wavelength plan

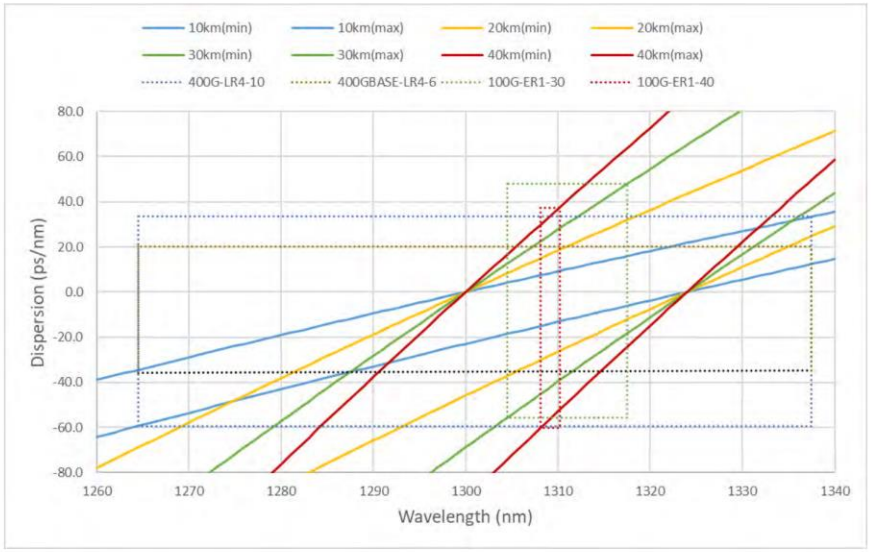
- During the February meeting, a straw poll #1 showed support for using the BR20 specification with LAN WDM channel spacing.
  https://www.ieee802.org/3/dk/public/2302/2302_8023dk_unapproved_minutes.pdf

> **Discussions, straw-polls, other motions**
>
> Straw poll #1: I support specification of 100 Gb/s per wavelength for 10 km and 20 km objectives (1304.6 and 1309.1 nm). (17 attendees)
> Y: 13 N: 0 Need more info: 0

- In the following March meeting, the possibility of using CWDM channel spacing for the wavelength plans of BR20 was discussed again. The economic benefits of laser diodes and the fact that CWDM can provide sufficient bandgap for a typical T-shaped BOSA implementation were considered. https://www.ieee802.org/3/dk/public/2303/3dk_Mi_2303_1.pdf
- In the last meeting, it was pointed out that using CWDM channel spacing would make BOSA implementation easier, but it would also create difficulties in solving the problem of chromatic dispersion induced penalty of the transmitted signal.
  https://www.ieee802.org/3/dk/public/2304/3dk_Effenberger_2304_1.pdf
- It is supported upon to adopt the LAN-WDM channel spacing for the BR20 wavelength plan. This decision makes the BOSA implementation slightly more complicated, but it also makes it easier to solve the problem of chromatic dispersion induced penalty.

100Gb/s based BR40 wavelength plan

100G PAM4 CD limits



- 400G-LR4-10 CD limits are -59.4 to +33.4 ps/nm supporting multiple TX technologies
- Assume that practical CD limits for BiDi are -60 to +35 ps/nm
- CD-limited wavelength range is tight for 30 and 40km reaches

Reach (km)	WL at -60 ps/nm (nm)	WL at +35 ps/nm (nm)	CD-Limited WL Range (nm)
10	1263.9	1337.5	73.6
20	1292.9	1322.0	29.2
30	1303.0	1314.6	11.6
40	1308.2	1310.9	2.7

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- According to this result, the wavelength band for BR40 is 2.7nm, so a DWDM (100GHz) channel spacing configuration should be possible.
- However, it requires an O-band DWDM LD with precise wavelength control technology. It will be very difficult to implement BOSA because the guard band is about 1nm.

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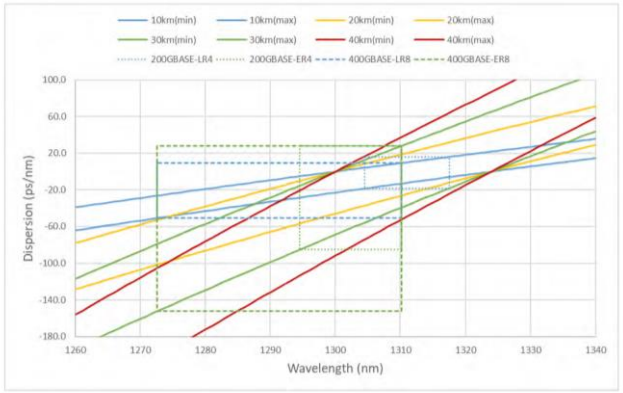
50Gb/s based BR40 wavelength plan

50G PAM4 CD limits



- Conservative 400GBASE-ER8 30km CD limits are -152.5 to +28.1 ps/nm
- Assume that practical CD limits for BiDi are -160 to +50 ps/nm

Reach (km)	WL at -160 ps/nm (nm)	WL at +50 ps/nm (nm)	CD-Limited WL Range (nm)
10	*1264.5*	1337.5	73.0
20	*1264.5*	1327.7	63.2
30	1270.2	1318.3	48.1
40	1283.0	1313.7	30.7

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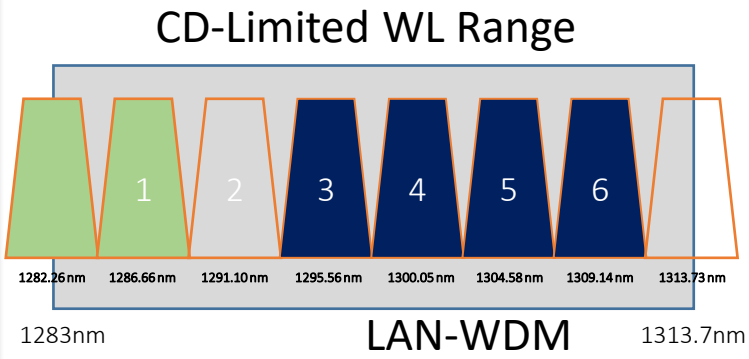
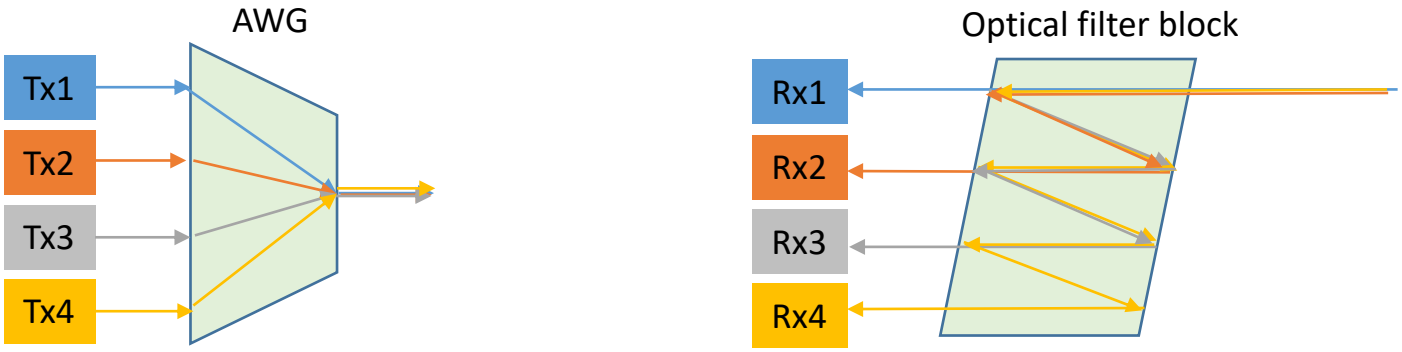


- Reducing the signal rate of BR40 from 100 Gb/s to 50 Gb/s results in an increase of the CD-limited WL range by a factor of 10, up to 30.7 nm.
- With this expanded range, it is possible to configure 2x50 Gb/s up/down channels with 800GHz channel spacing, as the range can accommodate six channelsas shown in the figure.
- This approach also has the advantage of being compatible with commercially available LAN-WDM LDs such as 25G EML.

2 x 50Gb/s BOSA implementation

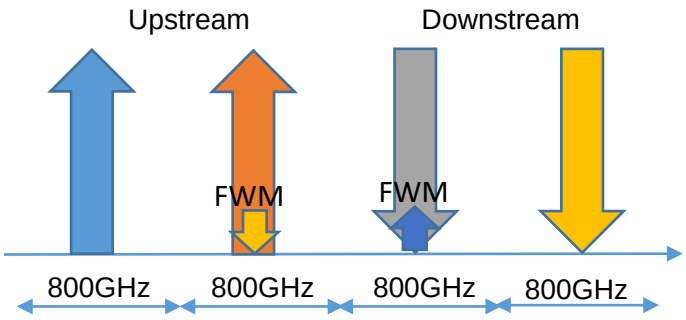
- Implementing a two-channel BOSA may be more complex than a single-channel BOSA, but it can be achieved by using technology similar to that used in 4-channel ROSA or 4-channel TOSA for Ethernet transceivers.
- Additionally, it would be possible to make MUX/DeMUX for two upstream and downstream by using a single AWG shown in the figure. To keep the BOSA size small, AWGs or optical filter blocks could be utilized, and the channel spacing could be kept to LWDM spacing.
- Although a 2x50G BOSA would require more LDs and PDs, the lower cost of 50G photonics relative to 100G photonics is also a consideration point.

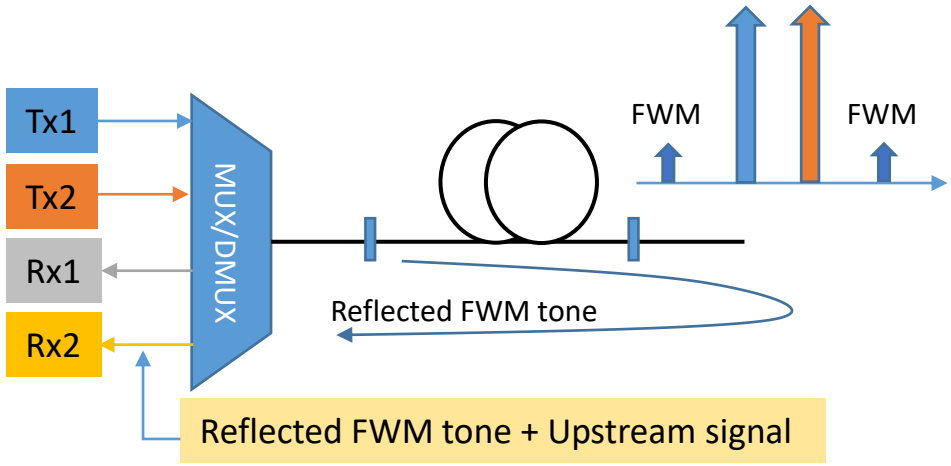


< Optical multiplexing configuration for 4 channels >

Four-wave mixing issue in optical link

- Using four equally spaced wavelengths as the up and downstream signals could lead to FWM in optical link with 40 km SMF.
- Since the downstream and upstream signal groups have different traveling directions, the FWM effect caused by interaction between the channel groups would be expected to be lower compared to ER4 case (all four channel travel in same direction).
- It's possible that FWM tones can be reflected at the optical link and is input to the optical receiver of the BOSA. The FWM tones can lead inter-channel crosstalk with the original received optical signal.
- In the next meeting, we will report the potential FWM impact between channel groups that travel in different directions.





Summary

- Based on the current ZDW specification of G.652 fiber, it is clear that a LAN-WDM based 2x 50Gb/s wavelength plan is a suitable solution to meet the distance requirement for BR40.
- Small package 2x50Gb/s BOSA could be done using single AWG or optical blocks which was used popularly by four channel ROSA and TOSA for ER4 application.
- There have been recent efforts to reduce ZDW spec. of G.652 fiber to better utilize the O-band. Reduced ZDW spec. will be appropriate for recent deployed optical link and it may be more appropriate to use the existing ZDW spec. in areas where a lot of legacy fiber is already deployed.
- It is proposed that a 2x50Gb/s BR40 wavelength plan be decided upon first, and then a discussion of a 100Gb/s based BR40 wavelength plan can occur after the G.652 ZDW specification is updated.