Considerations on 100G and 200G Bidi Optics

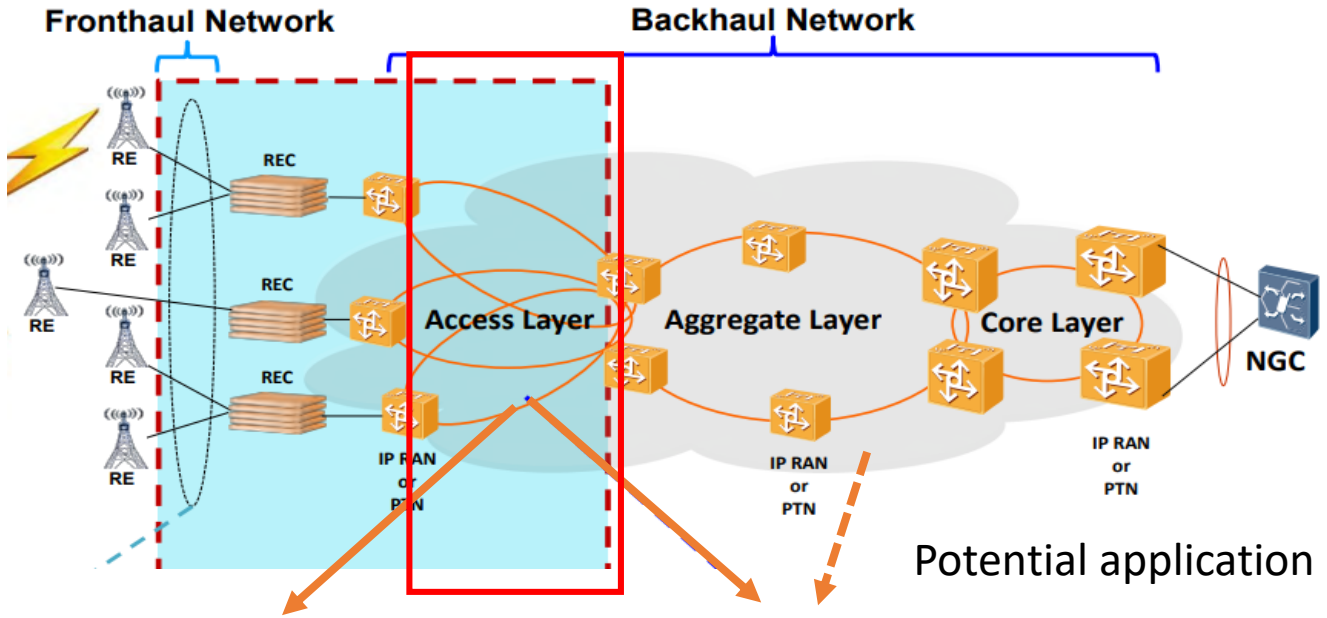
Guangcan Mi /Huawei

HUAWEI

Introduction

- In 2022.09 meeting, the following objectives were approved by GT50G SG
  - 100G MAC Rate Bidi operation
  - 200G MAC Rate Bidi operation
  - Fiber link of 10/20/40km for both rates
- Use case for the interested Bidi Optics ranges over mobile front haul, PON and Metro access network. The diverse application requires the Optics to adapt to
  - multiple generations of equipment with different serdes technology
  - various operation environment
- From a standard point of view, it is important that the variety of application/market is recognized and supported, while not making the technical choice too fragmented. i.e. so that the standardized technical choice(s) could exploit the benbefit of broad market potential and large volume to arrive at low cost.
- This contribution discusses possible technical solutions for the established objective, pointing out the challenges faced by different solutions, hoping to inspire more technical discussion in this task force

100G BIDI PtP in IP Market

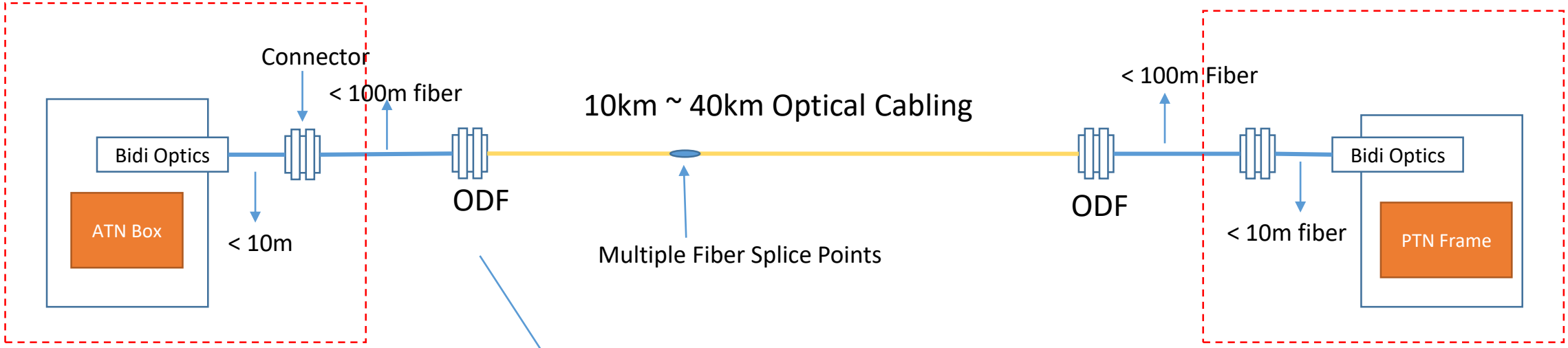


10km 60~70% of deployed

40km 20%

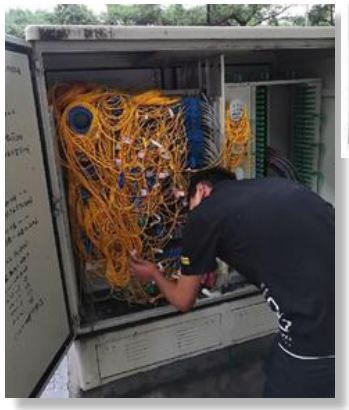
Current	Port rate 25G	50G
~2025	50G 100G	50G 100G
2025 beyond	100G	400G

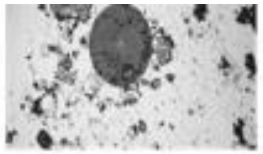
Typical Optical Cabling for Mobile Transport Network

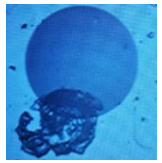


ATN Boxes：
Temperature Controlled/Vented
Mostly Outdoor or Less managed：
Cabinet、 Roof-top CO room

PTN frame：
Air Conditioned & Well Managed:
designated CO facility





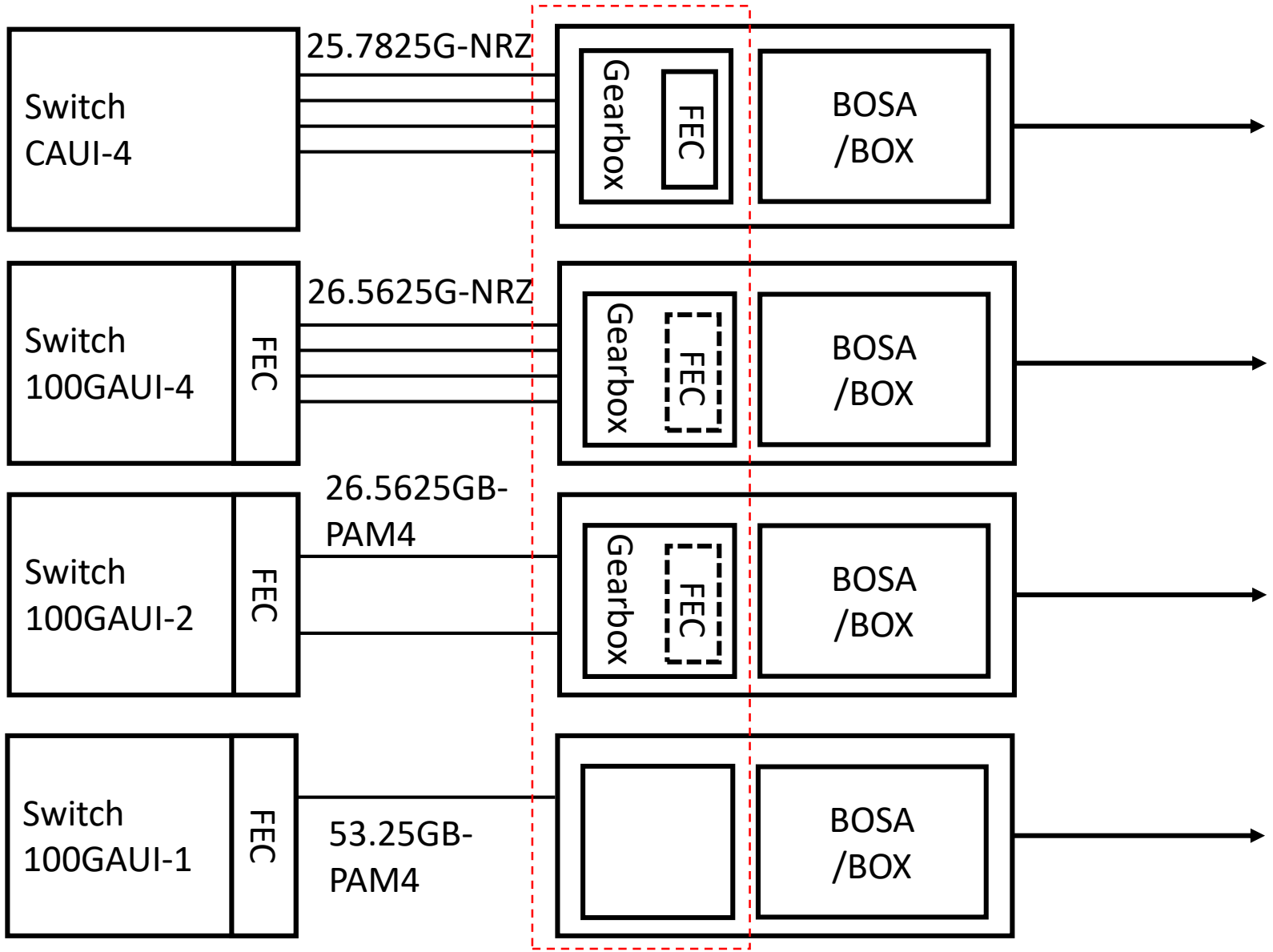


Contaminated fiber connectors commonly seen at both optical module and ODF:

- Effectively Higher link loss than standardized
- Increased MPI penalty
- Wider Temperature Range than DC cases

Sufficient Engineering Margin beyond the link budget defined in standards is crucial in real deployment.
This relies on both low Rx Sensitivity and low BER floor.

100G Bidi Optics: System Interfacing



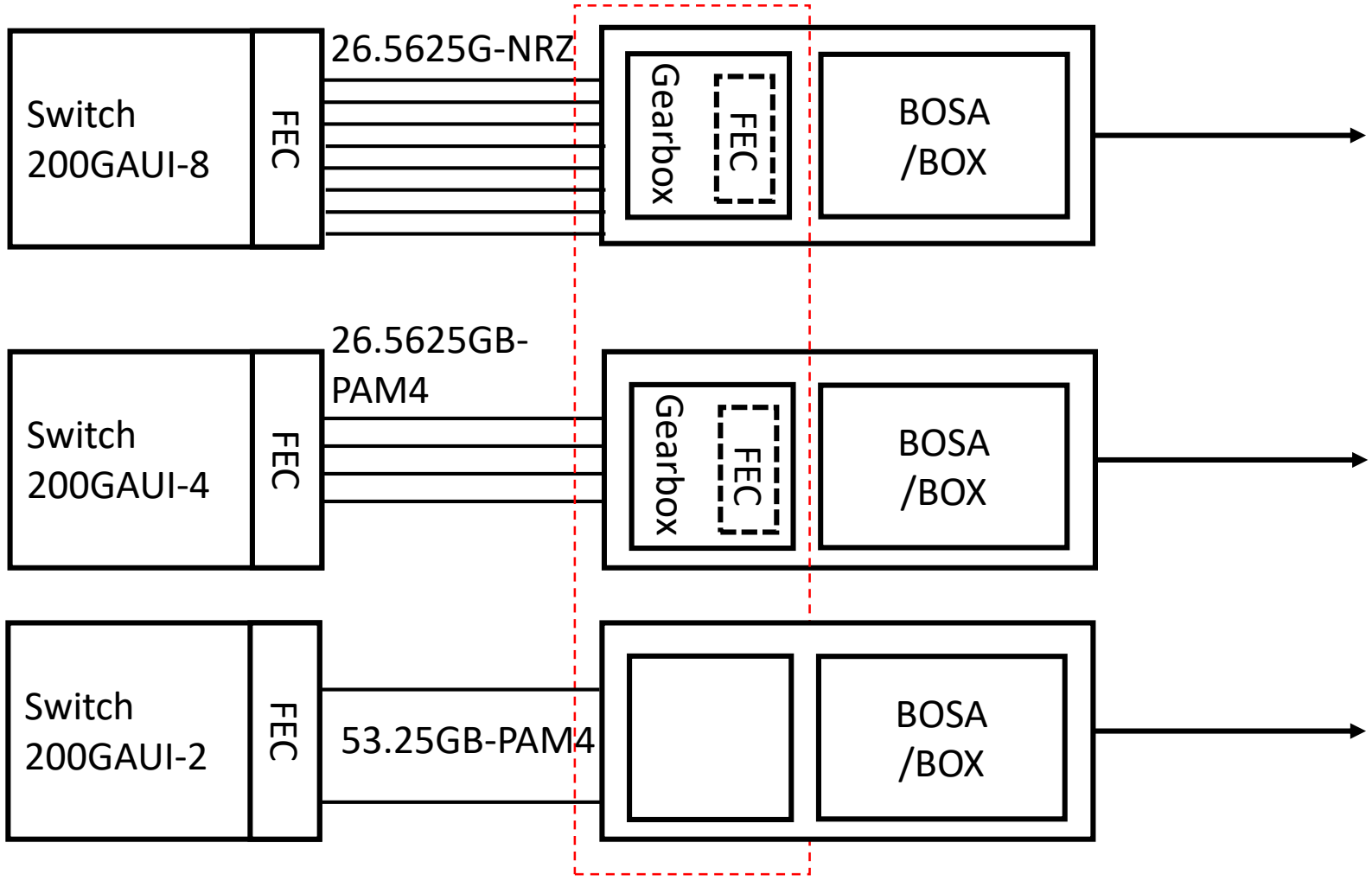
Optical Interface

1x100G-PAM4

or

2x50G-PAM4

200G Bidi Optics: System Interfacing



Optical Interface

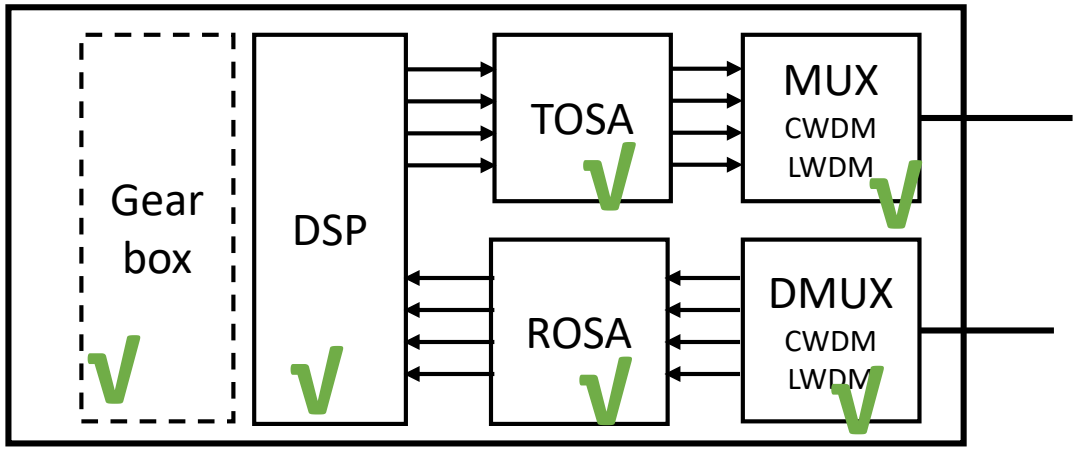
2x100G-PAM4

or

4x50G-PAM4

Leveraging the 50G/lam investment for 100G-Bidi Optics

200G-LR4、200G-ER4



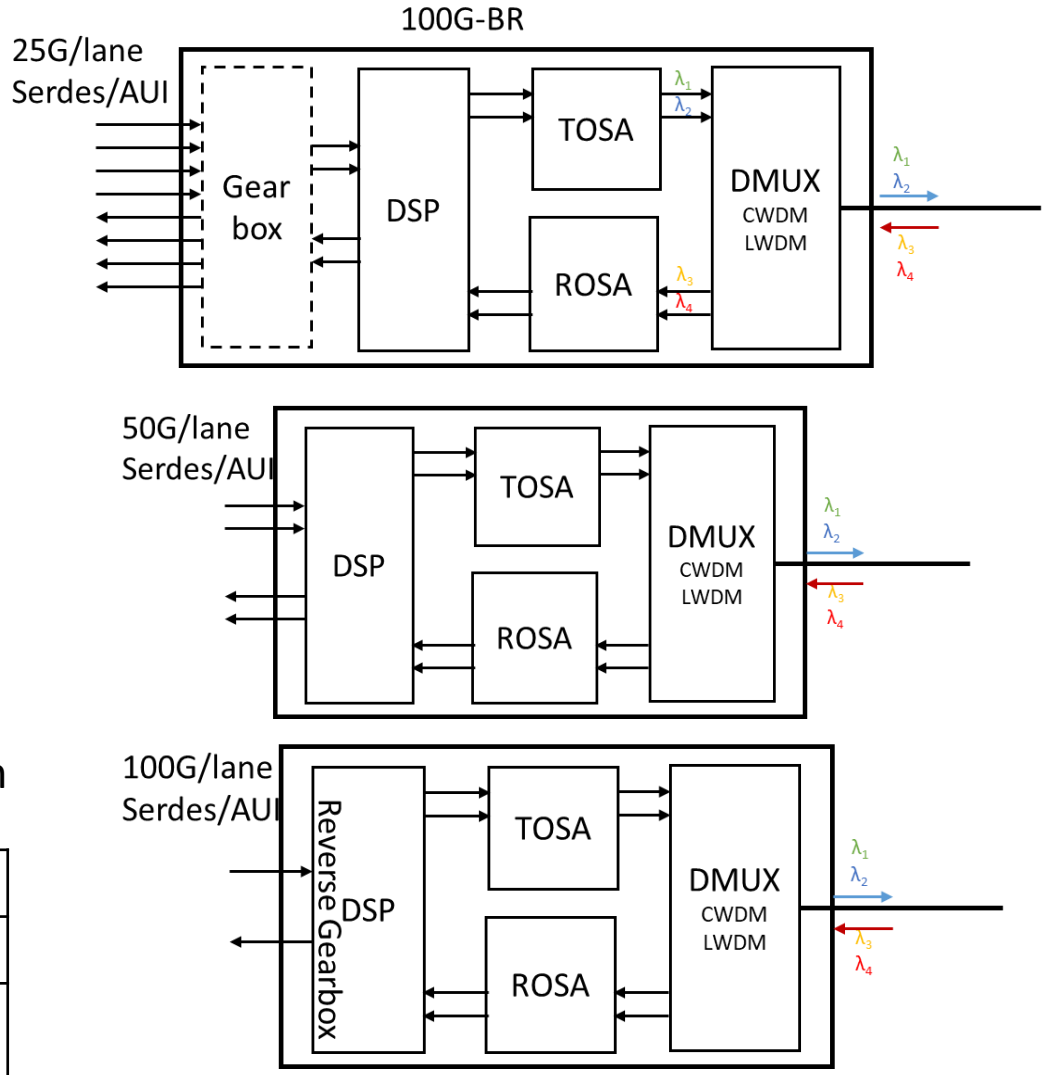
802.3cp **Table 160–6—50GBASE-BRx transmit characteristics**

Description	50GBASE-BR10	50GBASE-BR20	50GBASE-BR40	Unit
Signaling rate (range)	26.5625 ± 100 ppm			GBd
Modulation format	PAM4			—
50GBASE-BRx-D center wavelengths (range)	1320 to 1340	1306 to 1322		nm
50GBASE-BRx-U center wavelengths (range)	1260 to 1280	1281 to 1297		nm

Inclusion

	Possible Wavelength Plan	
10km	1271±6.5nm/1291±6.5nm	1311±6.5nm/1331±6.5nm
10/20km/40 km	1294.53 ~ 1296.59 1299.02 ~ 1301.09	1303.54 ~ 1305.63 1308.09 ~ 1310.19

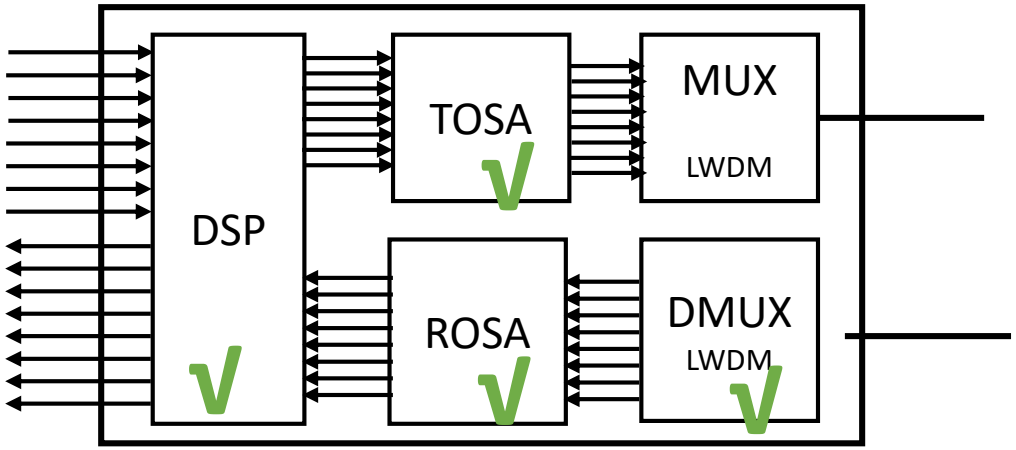
100G-BR



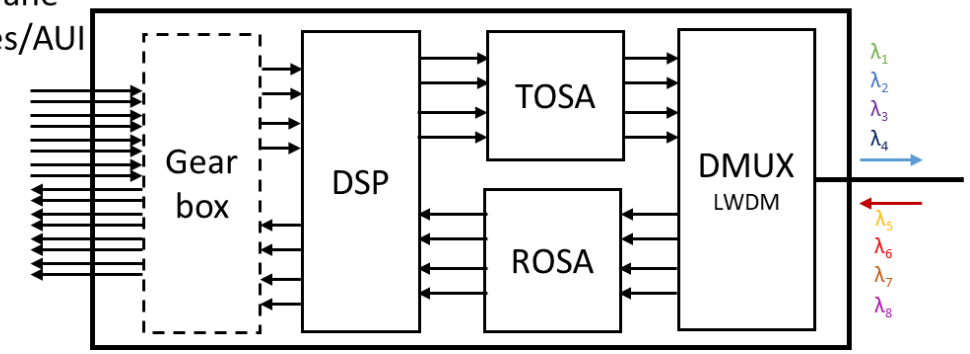
IEEE 802.3-2022's 50GBASE-BRx, 200GBASE-LR4 and 200GBASE-ER4 provide a good reference point for baseline

Leveraging the 50G/lane investment for 200G-BR Optics

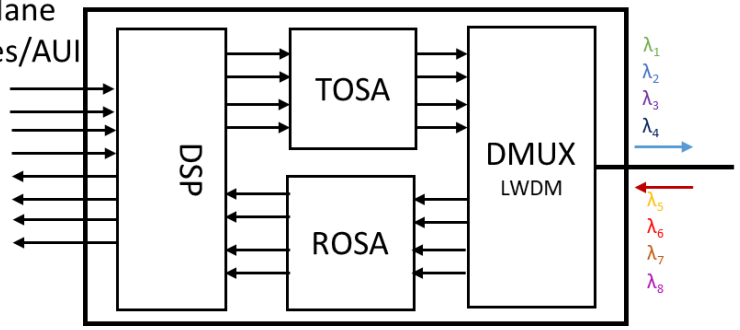
400G-LR8、400G-ER8



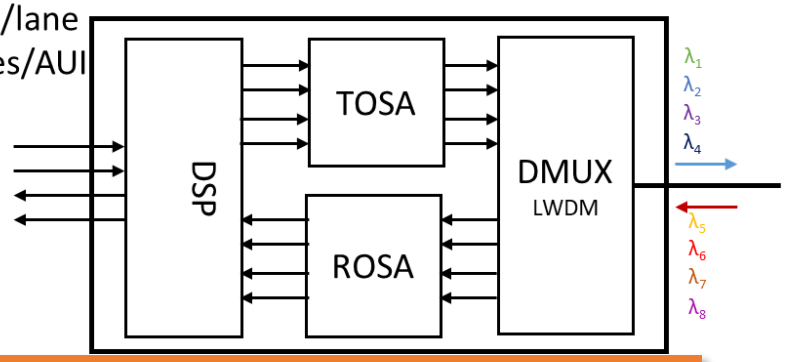
25G/lane Serdes/AUI



50G/lane Serdes/AUI



100G/lane Serdes/AUI

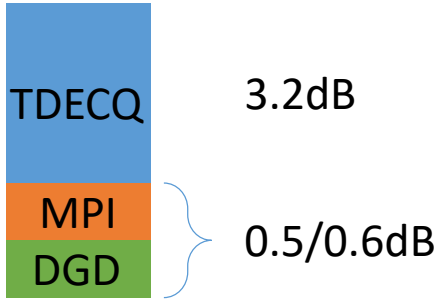


	Possible Wavelength Plan	
10/20km/40 km	1272.55 to 1274.54 nm 1276.89 to 1278.89 nm 1281.25 to 1283.27 nm 1285.65 to 1287.68 nm	1294.53 ~ 1296.59nm 1299.02 ~ 1301.09nm 1303.54 ~ 1305.63nmm 1308.09 ~ 1310.19nm

IEEE 802.3-2022's 50GBASE-BRx, 400GBASE-LR8 and 400GBASE-ER8 provide a good reference point for baseline

Link budget based on 2x50G Bidi Optics

	10km	20km	40km	
power budget(dB)	10.1	18.7	21.7	
channel IL(dB)	6.3	15	18	
maxim discrete reflectance(dB)	-26	-35	-35	Same as 802.3cp
allocation for penalties (dB)	3.8	3.7	3.7	Same as 802.3cn
Max positive dispersion(ps)	33.43	18.53	37.06	100G Bidi
Min negative dispersion(ps)	-59.36	-56.10	-112.21	
Max positive dispersion(ps)	9.27	18.53	37.06	200G Bidi
Min negative dispersion(ps)	-50.28	-100.56	-201.13	



Extending the 100G/lam Optics to 40km(1) 100G Bidi

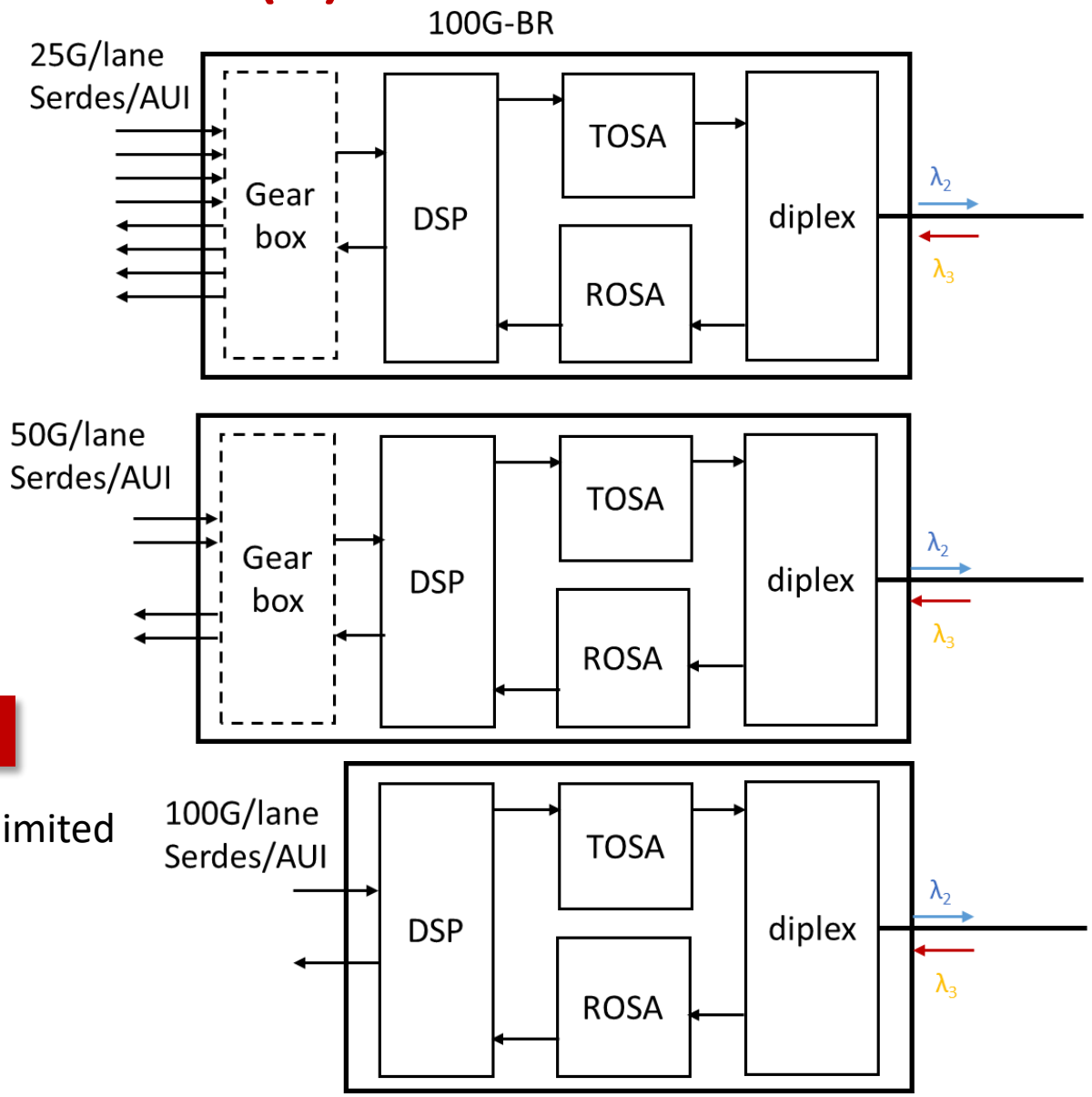
	Wavelength Plan Choices on the table	
	10km	20km/40km
802.3 cu	1291±6.5nm/1311±6.5nm (dispersion limited)	NA
100G LAMBDA MSA*	1291±6.5nm/1311±6.5nm 1271±6.5nm/1331±6.5nm	Tx: 1308.09 ~ 1310.19 Rx: 1304.5 to 1317.5

Pick 2

New Investment on EMLs

Tx Not wide enough for 2 wl.s: CD limited

{ 1308.09 ~ 1310.19
  1312.68~1314.78



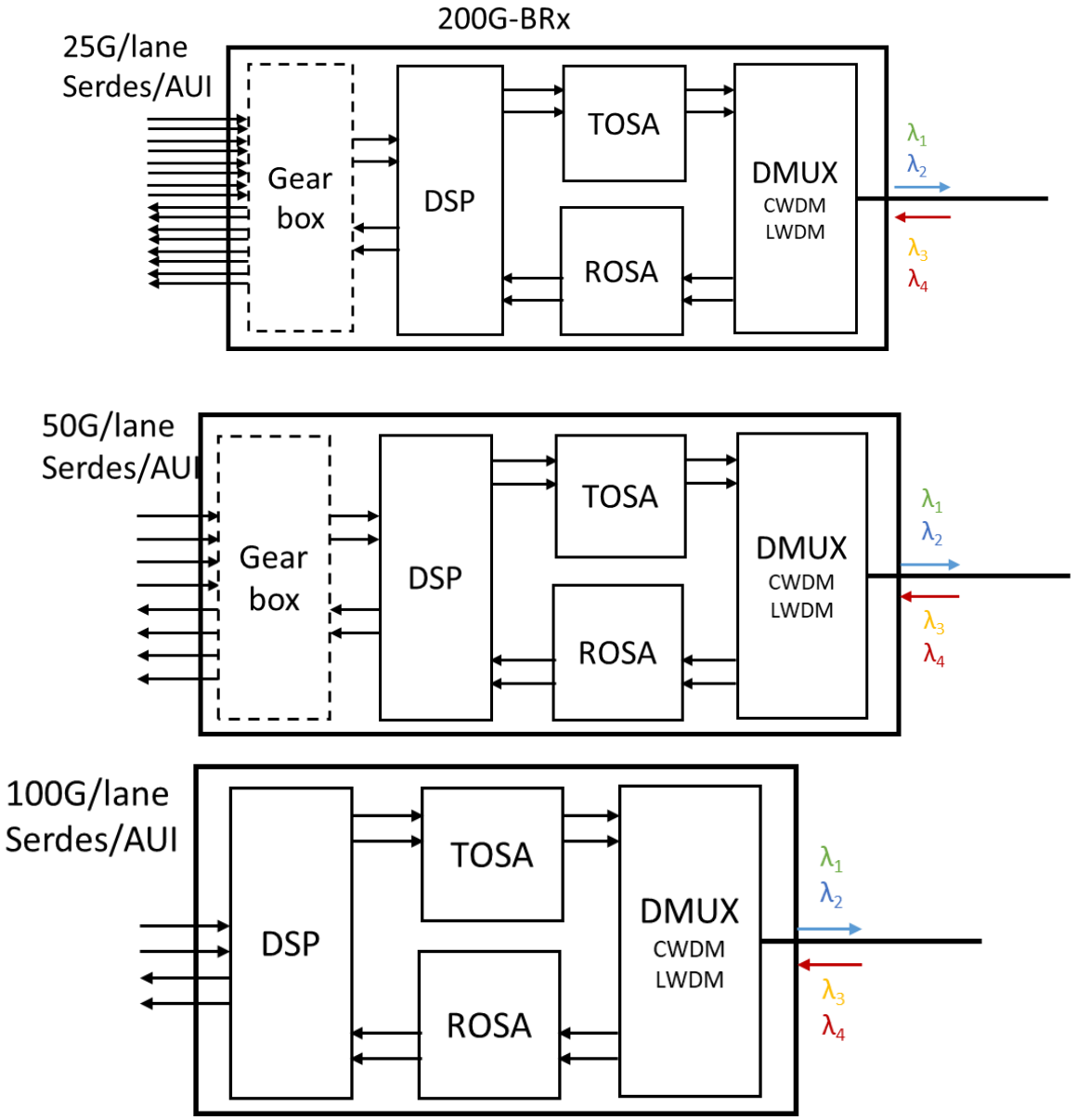
*: The work of 400G-ER4-30 in 100G LAMBDA MSA is still on going, reference is made to 400G-LR4-10 and 100G-ER-20/40

Extending the 100G/lam Optics to 40km(2) 200G Bidi

	Wavelength Plan Choices on the table	
	10km	20km/40km
802.3 cu	1291±6.5nm/1311±6.5nm (dispersion limited)	NA
100G LAMBDA MSA*	1291±6.5nm/1311±6.5nm 1271±6.5nm/1331±6.5nm	Tx: 1308.09 ~ 1310.19 Rx: 1304.5 to 1317.5

Enough wavelength range to allow 4 LWDM wavelength

No immediate answer to a feasible wavelength plan

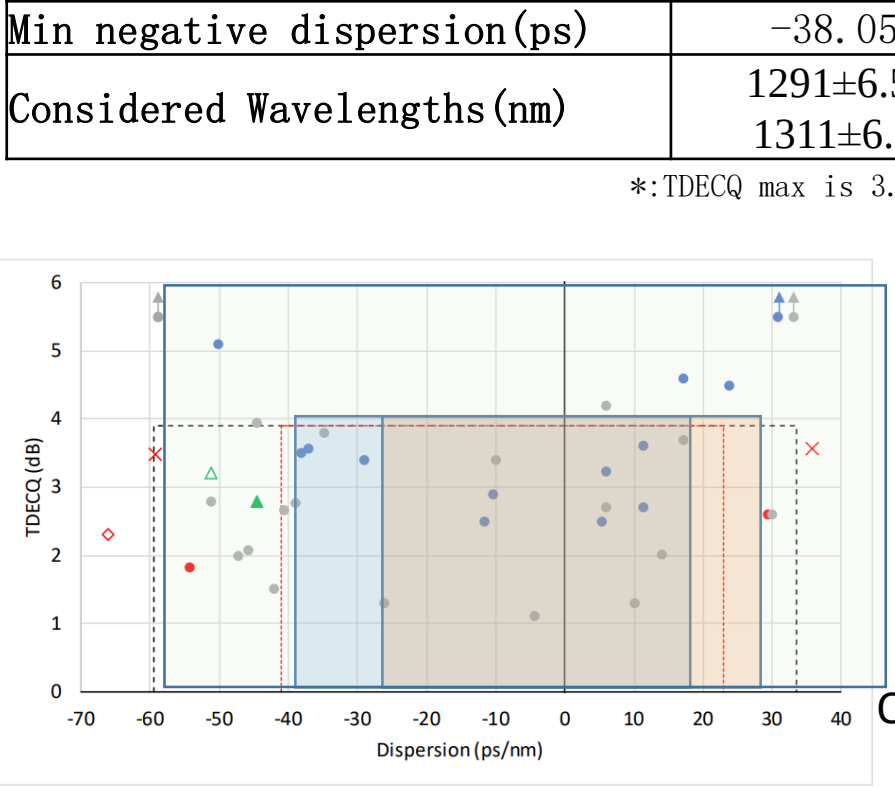


*: The work of 400G-ER4-30 in 100G LAMBDA MSA is still on going, reference is made to 400G-LR4-10 and 100G-ER-20/40

Link budget of 1x100G based Bidi Optics

	10km	20km	40km	
power budget(dB)	11	19.4	22.5	
channel IL(dB)	6.3	15	18	
maxim discrete reflectance(dB)	-33@4connector	-35	-35	
allocation for penalties (dB)	4.3*	?4.4	?4.4	
Max positive dispersion(ps)	15.78	26.74	53.48	
Min negative dispersion(ps)	-38.05	-28.27	-56.54	
Considered Wavelengths(nm)	1291±6.5/ 1311±6.5	1308.09 ~ 1310.19 1312.68~ 1314.78		

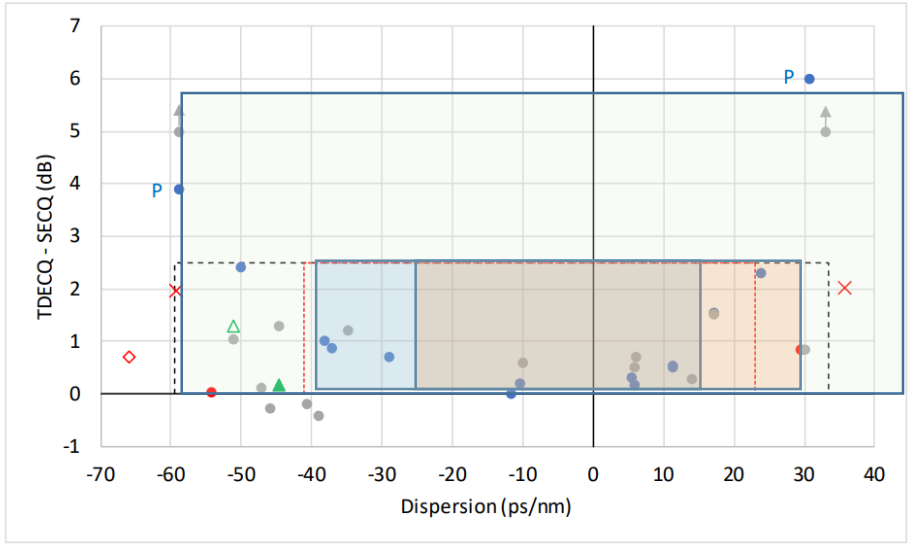
*:TDECQ max is 3.4dB in IEEE 100G-LR1



IEEE/100G Lambda MSA 3.4/3.9dB

0.9/0.5dB

?: As defined in 100G LAMBDA MSA for 100G-ER-20 and 100G-ER-40



https://www.ieee802.org/3/cu/public/Sept19/stassar_3cu_01_0919.pdf

Correlation with IEEE base standard

			PMD	Logic & Electrical
100G Bidi	2*50G 10km	200G-LR4	IEEE 802.3-2022 cl122	Cl91 RS FEC/Cl 82 PCS Cl 83/135 100GBASE-R/P PMA Annex 83E/135E/120G/135G AUI
	2*50G 20/40km	200G-ER4		
200G Bidi	4*50G 10km	400G-LR8		Cl 119 PCS Cl120 PMA Annex 83E/135E/120C/120E/120G/135G AUI
	4*50G 20/40km	400G-ER8		

			PMD	AUI
100G Bidi	1*100G 10km	100G-LR1*	cl140	Same as 50G based
	1*100G 20/40km	NA	NA	
200G Bidi	2*100G 10km	NA	NA	
	2*100G 20/40km	NA	NA	

*: with modification of wavelength

Summary

- The upgrade of 5G network will promote the upgrade of mobile transport network, leading to the change from 25G Bidi optics to 50G/100G Bidi optics.
- PtP Grey link in IP Ran Network requires optics that are reliable and provides sufficient link budget margin to accommodate its diverse deployment environment, some of which :
  - uses older fibers
  - are less maintained and
  - can be in harsh temperature and high humidity.
- Technical situation faced by this TF is more complicated than the previous 802.3cp project, where 10/25/50G bidi optics each has a best single lambda choice available. While in this project, both 50G/λ and 100G/λ offer possible solutions to fulfill 100G/200G Bidi and both have some shortcomings, either cost-related or performance-related.
- 50G/λ could be used to develop 100G/200G Bidi Optics
  - 1 wavelength plan for the three cases 10/20/40km
  - Proven field feasibility and technical robustness with 200G-LR4/200G-ER4/400G-LR8/400G-ER8
- 100G/λ is also a candidate technology, but has challenges and concerns to answer
  - Simpler module structure, lower power consumption and possible reuse of the DC supply chain for 10km
  - New Tx EML needed for 20/40km due to new wavelengths
  - The concern on chromatic dispersion's impact on higher peed Bidi optics and long reach is a shared view, and has been previously discussed in johnson_nea_01a_220223.

Next Step

- Further investigation on link budget based on 50G/λ, which the WDM loss considered.
- New experimental data using 100G-LR and 100G-ER products needed to build confidence on its viability in 40km reach and 200G Bidi WDM opitcs.
- MPI penalty
- Non-linear issues due to WDM solution