

Challenges and opportunities when deploying pluggable 400G coherent optics

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Agenda

Technology Intro and Market forecast

- Use Cases
- 400ZR vs 400ZR+
- Market Outlook

Transmission Challenges

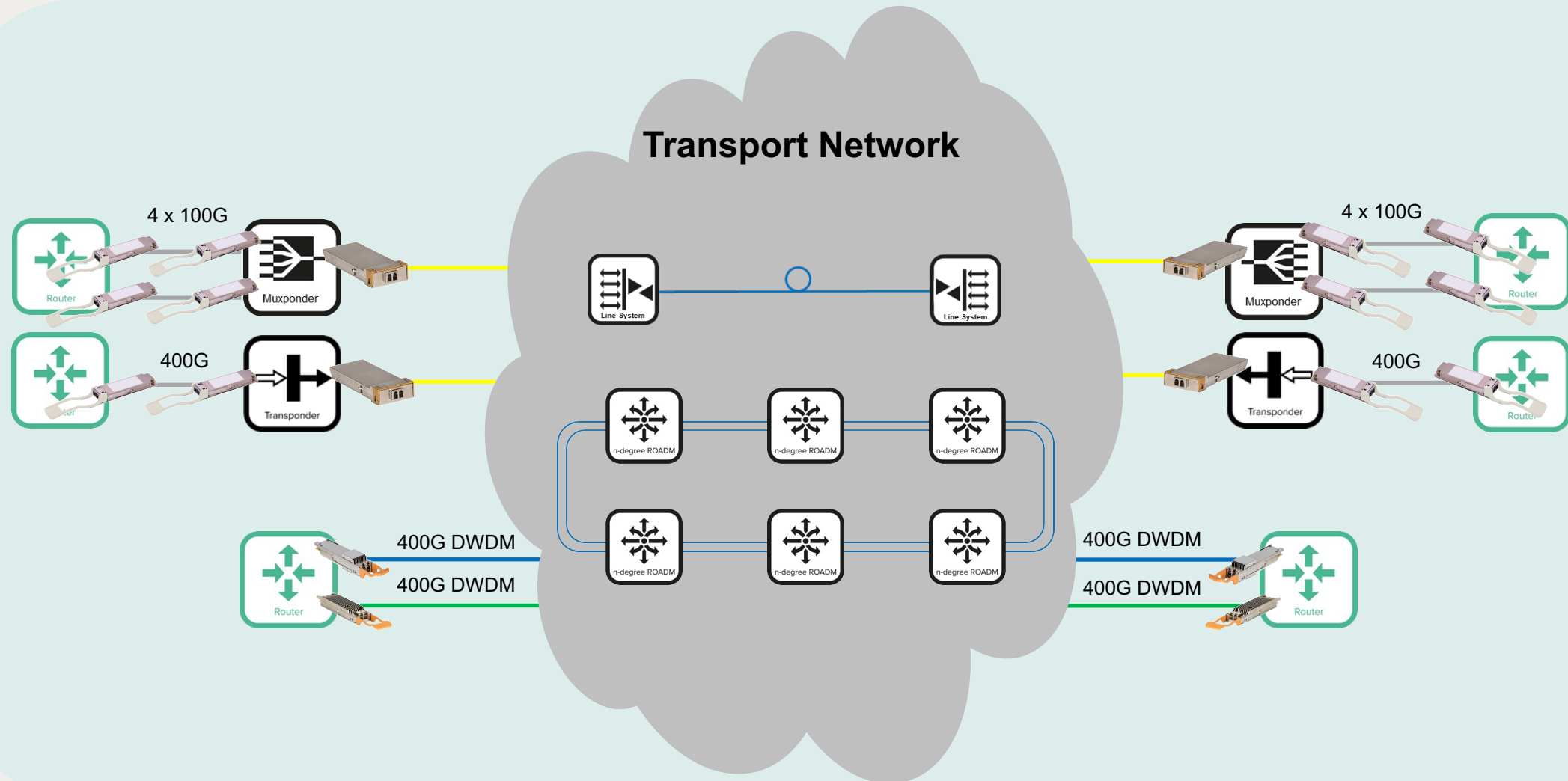
- Bandwidth challenges
- Tx Power challenges
- Support in Switches & Routers

Optical Performance Examples

- Point-to-Point Networks
- ROADM Networks



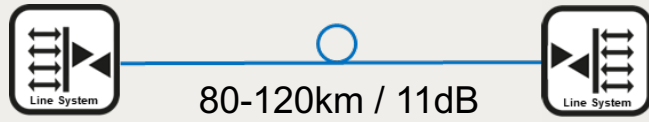
Use cases for pluggable 400G coherent optics



400ZR vs 400ZR+

400ZR

400ZR is standardized by

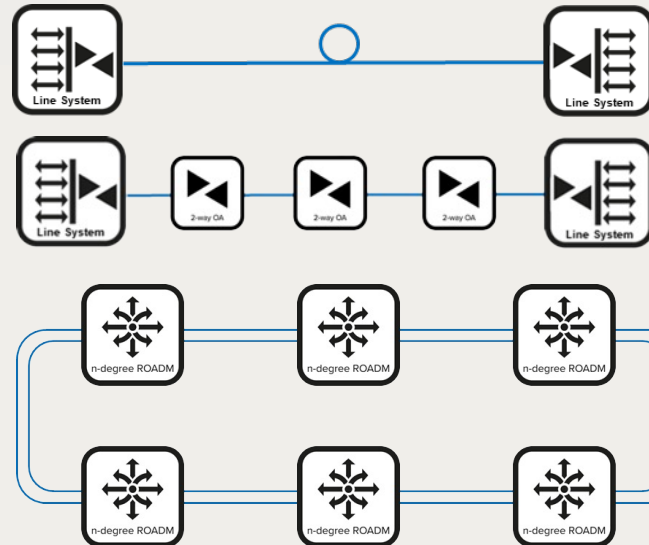


Well defined in all aspects



400ZR+

400ZR+ is not a standard, there are however several MSA's that falls under the 400ZR+ umbrella, plus proprietary implementation



Only OpenZR+ GA today for IP over DWDM

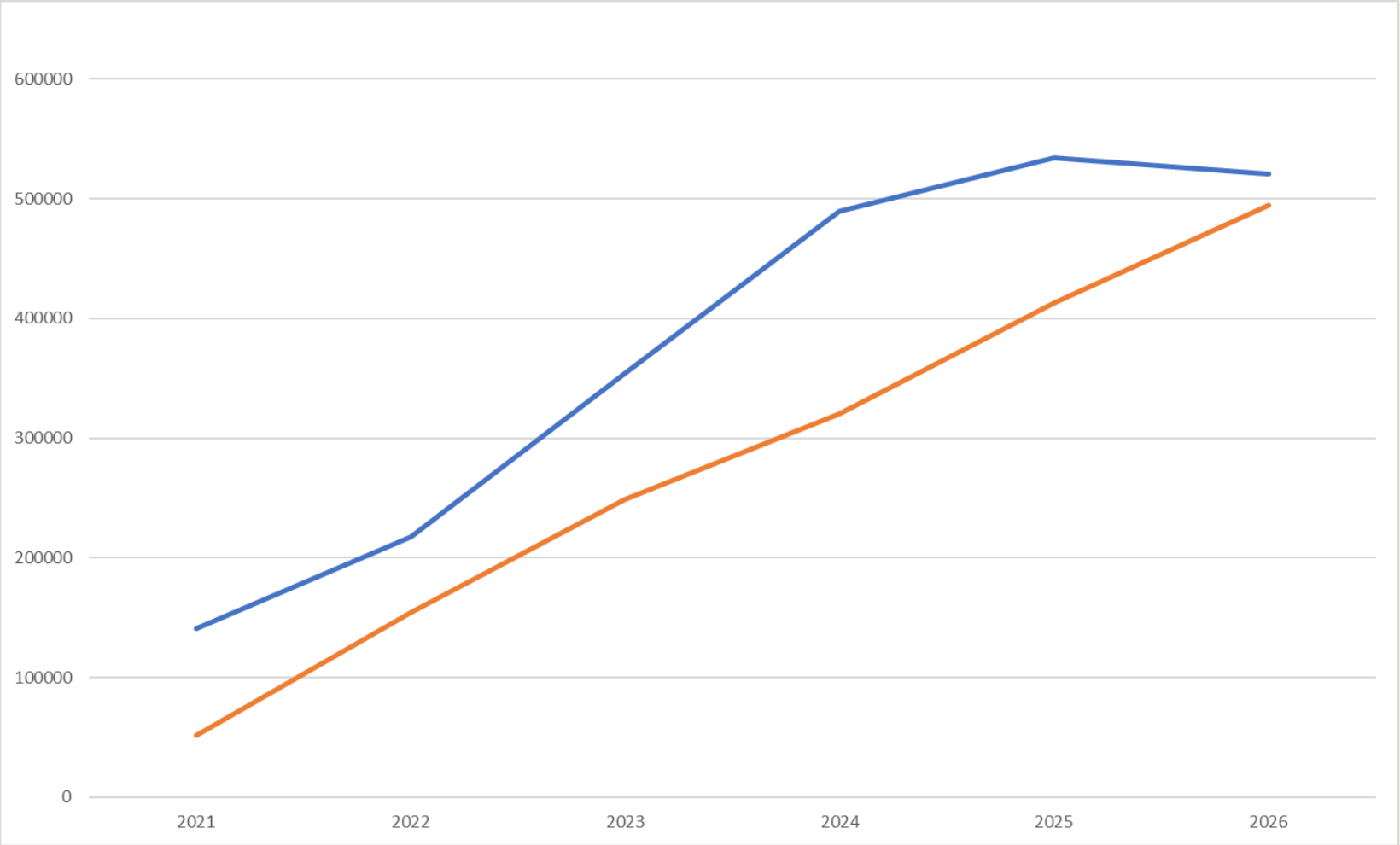
Typically requires Host implementation

Several CMIS versions

Application codes supported by OpenZR+

	CMIS Application Code	Host format	Electrical interface	Payload	FEC	Modulation	Operating reach	MSA format	
OIF 400ZR	1	400GBASE-R	1x 400GAUI-8 (8x 50G)	400G	CFEC	DP-16QAM	80km	OIF 400ZR app code 0x01	Common Router mode
	2	400GBASE-R	1x 400GAUI-8 (8x 50G)	400G	CFEC	DP-16QAM	25km	OIF 400ZR app code 0x02	
	3	4 x 100GBASE-R	4x 100GAUI-2 (2x 50G)	400G	CFEC	DP-16QAM	80km	OIF 400ZR extension	
OpenZR+	4	400GBASE-R	1x 400GAUI-8 (8x 50G)	400G	oFEC	DP-16QAM	120km	OpenZR+ MSA (small PMD)	
	5	400GBASE-R	1x 400GAUI-8 (8x 50G)	400G	oFEC	DP-16QAM	450km	OpenZR+ MSA	Transponder 400G
	6	4 x 100GBASE-R	4x 100GAUI-2 (2x 50G)	400G	oFEC	DP-16QAM	450km	OpenZR+ MSA	Muxponder 4 x 100G
	7	3 x 100GBASE-R	3x 100GAUI-2 (2x 50G)	300G	oFEC	DP-8QAM	600km	OpenZR+ MSA	
	8	400GBASE-R	1x 400GAUI-8 (8x 50G)	400G	oFEC	DP-16QAM	450km	OpenZR+ MSA	
	9	4 x 100GBASE-R	4x 100GAUI-2 (2x 50G)	400G	oFEC	DP-16QAM	450km	OpenZR+ MSA	
	10	3 x 100GBASE-R	3x 100GAUI-2 (2x 50G)	300G	oFEC	DP-8QAM	600km	OpenZR+ MSA	Muxponder 3 x 100G
	11	2x 100GBASE-R	2x 100GAUI-2 (2x 50G)	200G	oFEC	DP-QPSK	1000km	OpenZR+ MSA	Muxponder 2 x 100G
	12	2x 100GBASE-R	2 x CAUI4 (4x 25G) w/o FEC	200G	oFEC	DP-QPSK	1000km	OpenZR+ MSA	
	13	1x 100GBASE-R	1x 100GAUI-2 (2x 50G)	100G	oFEC	DP-QPSK	2000km	OpenZR+ MSA	Muxponder 1 x 100G
	14	1x 100GBASE-R	1 x CAUI4 (4x 25G) w/o FEC	100G	oFEC	DP-QPSK	2000km	OpenZR+ MSA	

400G DWDM Coherent Forecast



- 400G+ in Transponders & Muxponders
- 400ZRx for IP over DWDM

Source: Signal AI

Transmission Challenges

Optical challenges using 400ZR in passive networks

Typical bandwidth of a 400ZR signal: ~60-65GHz

Typical bandwidth of a OpenZR+ signal: ~63-70GHz (~30-35GHz when used in 100G mode)

TTF Filter Bandwidth

Typical bandwidth of 8ch DWDM filter: ~30 (<60)GHz



AWG Filter Loss

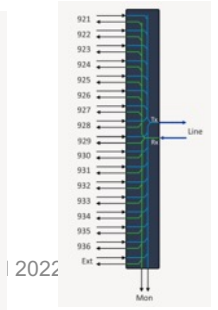
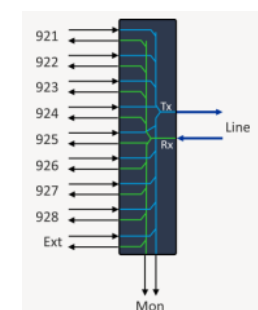
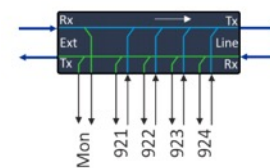
40ch Mux/Demux have sufficient bandwidth

40ch Mux/Demux loss: 12dB

400ZR Optical Budget: 11 dB



Solution: New filters with higher bandwidth



Tx Power for OpenZR+ optics

Tx Power Specification

OIF 400ZR: -6 to -10

OpenZR+: -6 to -10 (-13)

No Tunable Optical Filters (TOF)

Network Consequence

Green field deployments may work

Brown field deployments will most likely not work

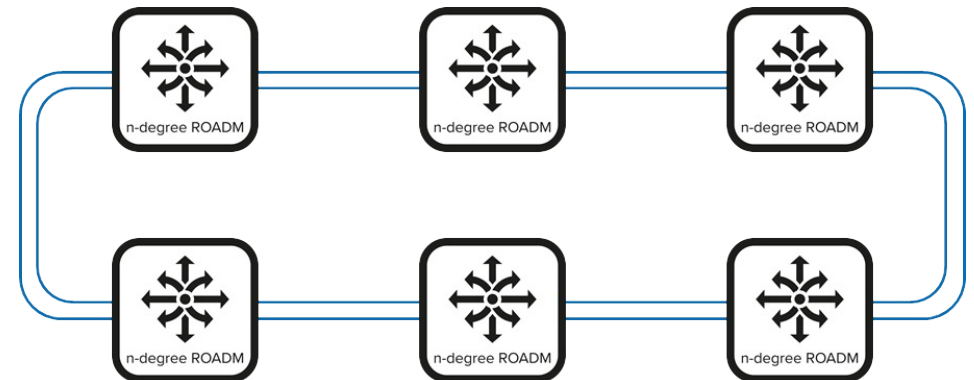
Solution

Good News!

QSFP-DD/OSFP Optics with High Tx Power will be available By the end of 2022.

Typical Requirements for Brown field networks:

- Line System Rx Power: 0dBm (~-4 to +4 dBm)
- Color less deployments typically requires TOF
- 50GHz spacing generate a bandwidth limitation



Router Support for 400ZRx

Our experience so far:

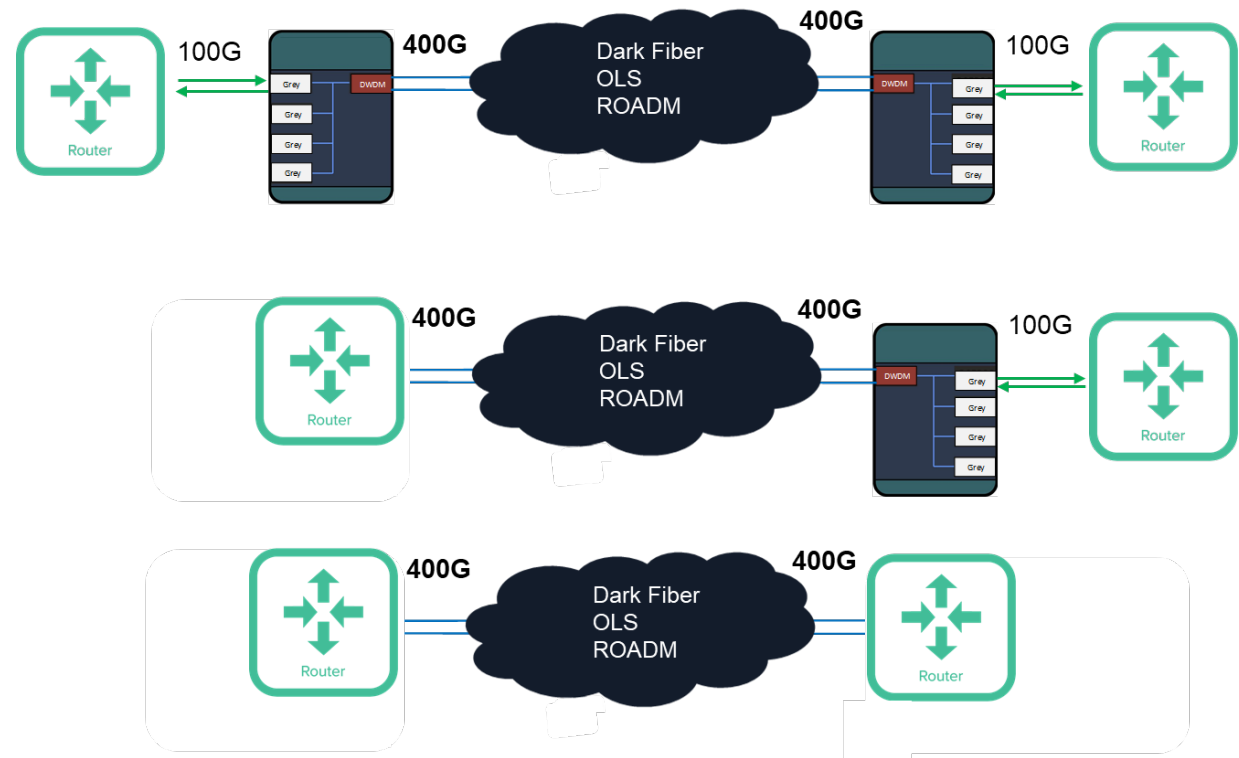
400ZR typically works in the routers

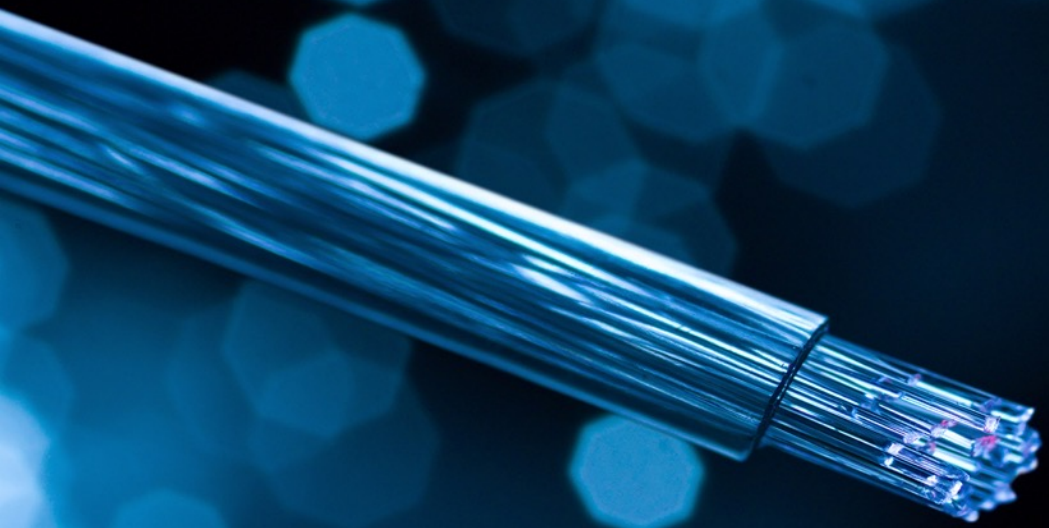
- Requires a specific SW
- Only certain blades or platforms support 400ZR today

OpenZR+ may work in the routers

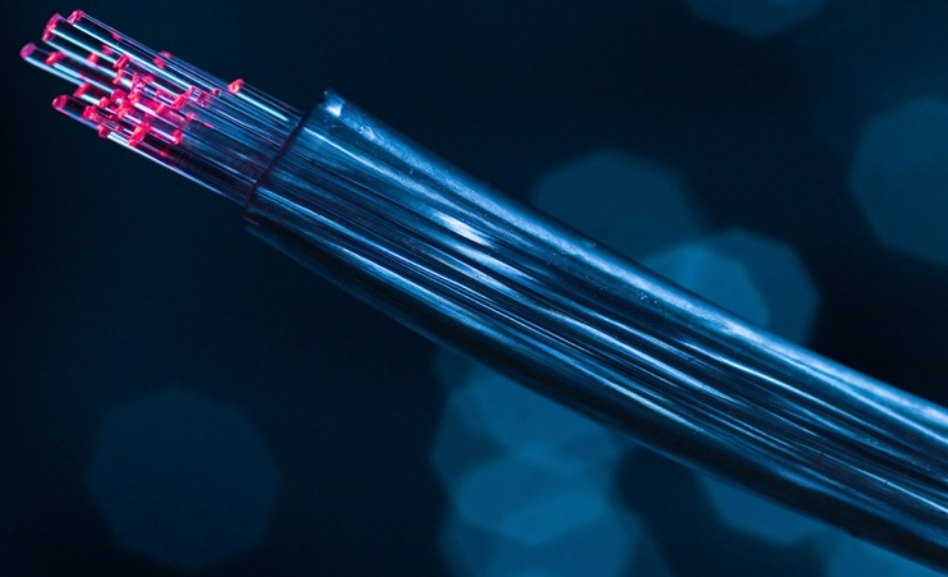
- Requires host implementation
- Typically, limited feature set available

Migration Plan





Optical Performance Examples



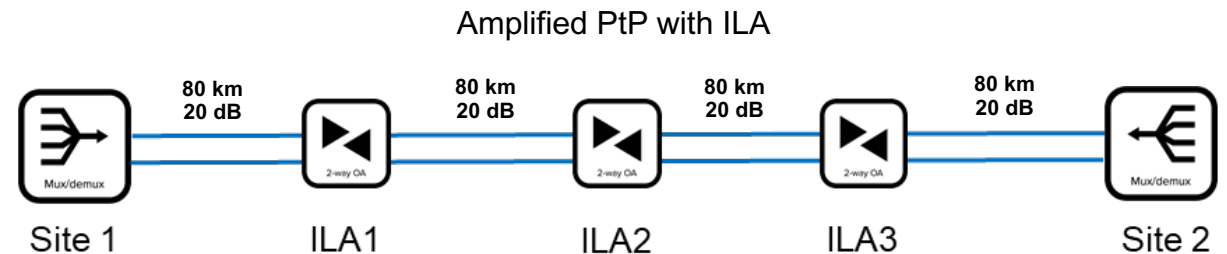
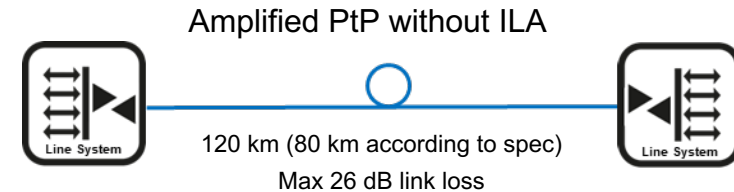
Optical performance in a 40ch point to point design

Assumptions:

- Amplifiers with optimum Gain = 22 dB
- Amplifiers Noise Figure = 5.5 dB
- All spans have 80km fiber with 20dB loss
- QSFP-DD with Tx power = -10dBm
- TX OSNR = 42dB
- No filter penalty or OSNR margin included

Traffic format	OSNR limit (dB)
400G ZR 16QAM	26dB (CFEC)
400G ZR+ 16QAM	23.4dB (OFEC, app 6)
300G 8QAM	20.3dB (OFEC, app 10)
200G QPSK	15dB (OFEC, app 11)
100G QPSK	11.8dB (OFEC, app 13)

Number of spans	OSNR (dB)*
1	31.1
2	29.3
3	28.0
4	27.0
5	26.2
6	25.5
7	24.9
8	24.4
9	24.0
10	23.5
15	21.9
20	20.9



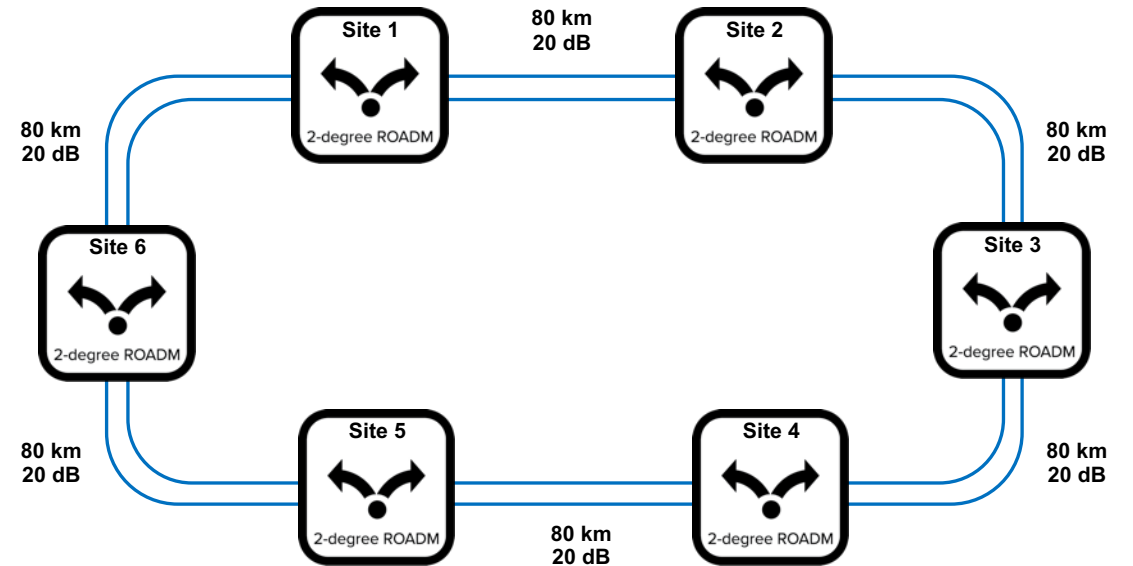
Optical performance in a 48ch 2-degree ROADM ring design

Assumptions:

- Amplifiers with optimum Gain = 22 dB
- Amplifiers Noise Figure = 5.5 dB
- All spans have 80km fiber with 20dB loss
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200G QPSK	15dB (OFEC, app 11)
100G QPSK	11.8dB (OFEC, app 13)

Number of spans	OSNR (dB)*
1	28.9
2	27.0
3	25.7
4	24.6
5	23.8
6	23.1
7	22.5
8	22.0
9	21.5
10	21.1
15	19.5



Thank You
