Coherent Technologies for Short Reach Applications

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Coherent interface trade-offs

Spectral efficiency

Performance

Flexibility

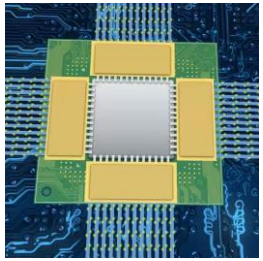
Energy efficiency

Cost efficiency

Compactness

Design choices depend on the application

Coherent applications



[image credit: CPO Collaboration]

Subsea/LH/Core

Integrated interfaces

400G-1.2T channels

Ultra-flexible modulation

What to watch

140GBd per lambda

Metro/DCI/Access

Pluggable modules

400G-ZR (QSFP-DD, 15W)

100…400G-ZR+ (CFP2, 25W)

What to watch

100G-ZR (QSFP28, 5W)

Intra-DC/Intra-Office

Transceiver chiplets

A future application?

Direct-detect modules today

What to watch

Co-packaged optics (CPO)

The interface alphabet soup

IEEE	500m PSM4	2km SMF	10km SMF	20km SMF	40km SMF	80km SMF
10GBASE-			BIDI Access	BIDI Access	BIDI Access	
25GBASE-			LR/ EPON/ BIDI Access	EPON/ BIDI Access	ER/ BIDI Access	
40GBASE-	PSM4	FR	LR4			
50GBASE-		FR	EPON/ BIDI Access LxR	EPON/ BIDI Access	BIDI Access ER	
100GBASE-	PSM4 DR	10X10-2km CWDM4/ FR1 100G-FR	10X10-10km LR4/ 4WDM-10 LR1 100G-LR	4WDM-20	ER4/ 4WDM-40	ZR
200GBASE-	DR4	FR4	LR4		ER4	
400GBASE-	DR4	FR8 FR4 400G-FR4	LR8 LR4-6 400G-LR4-10		ER8	ZR

Gray Text = IEEE Standard Red Text = In Standardization Green Text = In Study Group
Blue Text = Non-IEEE standard but complies to IEEE electrical interfaces

Current coherent module focus: ZR(+) interfaces (DWDM)

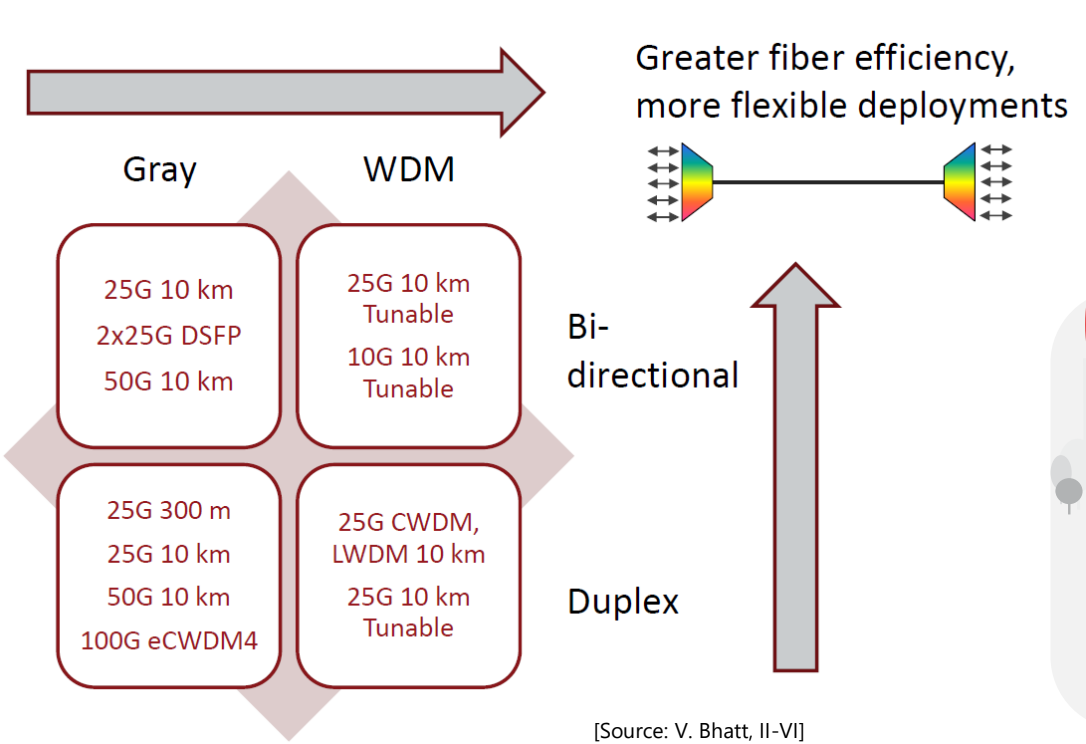
ZR(+) interface cheat sheet

Standard	Data rate	Interface	Modulation format	FEC	DWDM	Nom. Reach
ITU-T G.698.2/G.709.2 OpenROADM CableLabs	100G	OTU4-LR	DP-DQPSK	SC-FEC	100 & 50GHz 96ch. (50GHz) 100GHz	120km, 500km 500km, 1000km 120km
IEEE 802.3ct	100G	100GBASE-ZR	DP-DQPSK	SC-FEC	48ch. (100GHz)	80km
ITU-T G.698.2/G.709.3 OpenROADM CableLabs	200/400G 200/300/400G 200G	FlexO	DP-16QAM DP-QPSK/-8QAM/-16QAM DP-QPSK (DP-16QAM)	CFEC, OFEC OFEC OFEC	FlexGrid FlexGrid 100GHz (50GHz)	120km, 500km 500k, 1000km 120km
IEEE 802.3cw OIF	400G 400G	400GBASE-ZR 400ZR	DP-16QAM DP-16QAM	CFEC CFEC	64ch. (75GHz) 48/64 ch. (100/75GHz)	80km 120km

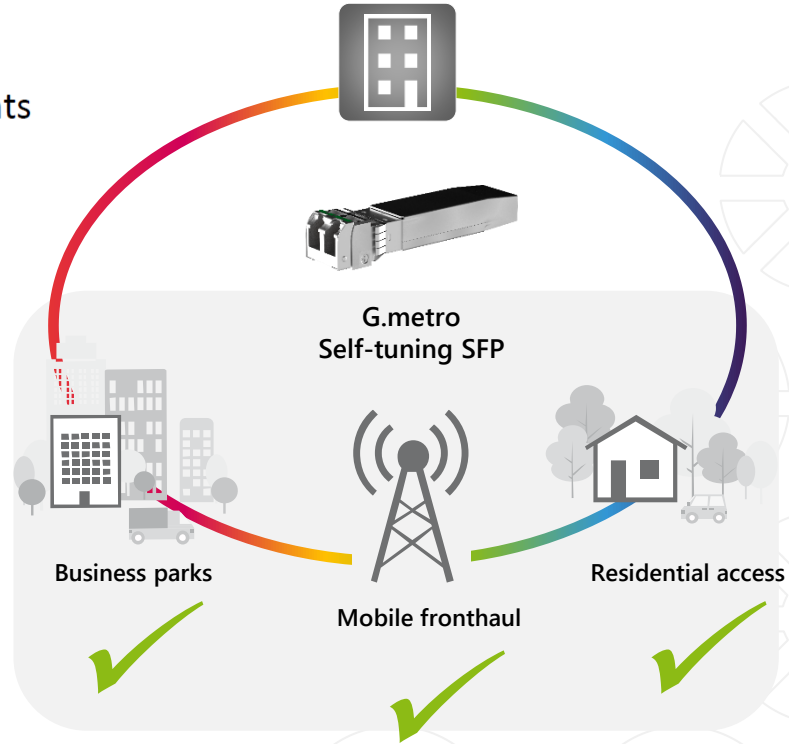
SC-FEC: Staircase-FEC, CFEC: Concatenated staircase & soft-decision Hamming FEC, OFEC: Open-FEC (spatially correlated product code based soft-decision FEC)

ZR+ often supports additional features & proprietary FECs

What about lower speed pluggables?



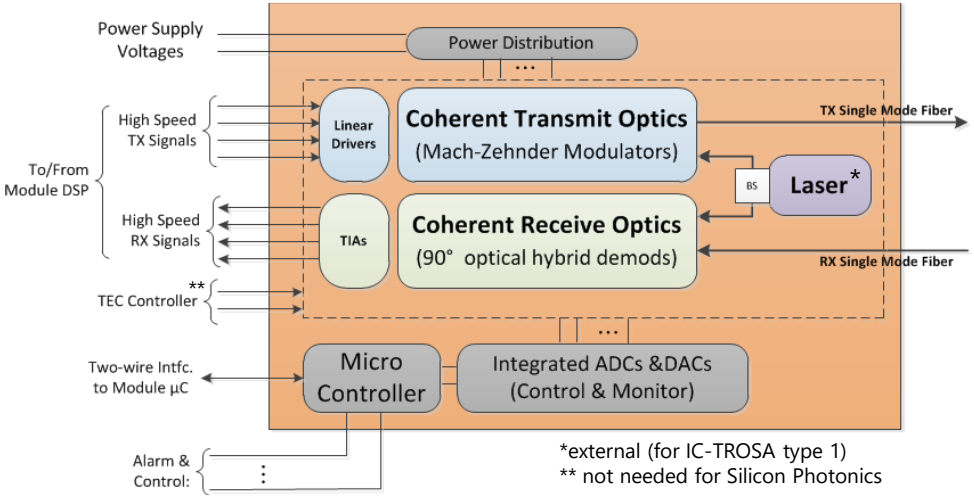
[Source: V. Bhatt, II-VI]



SFP form factor will make coherent implementations a challenge

What is important moving forward?

Electro-photonic integration



*external (for IC-TROSA type 1)
** not needed for Silicon Photonics

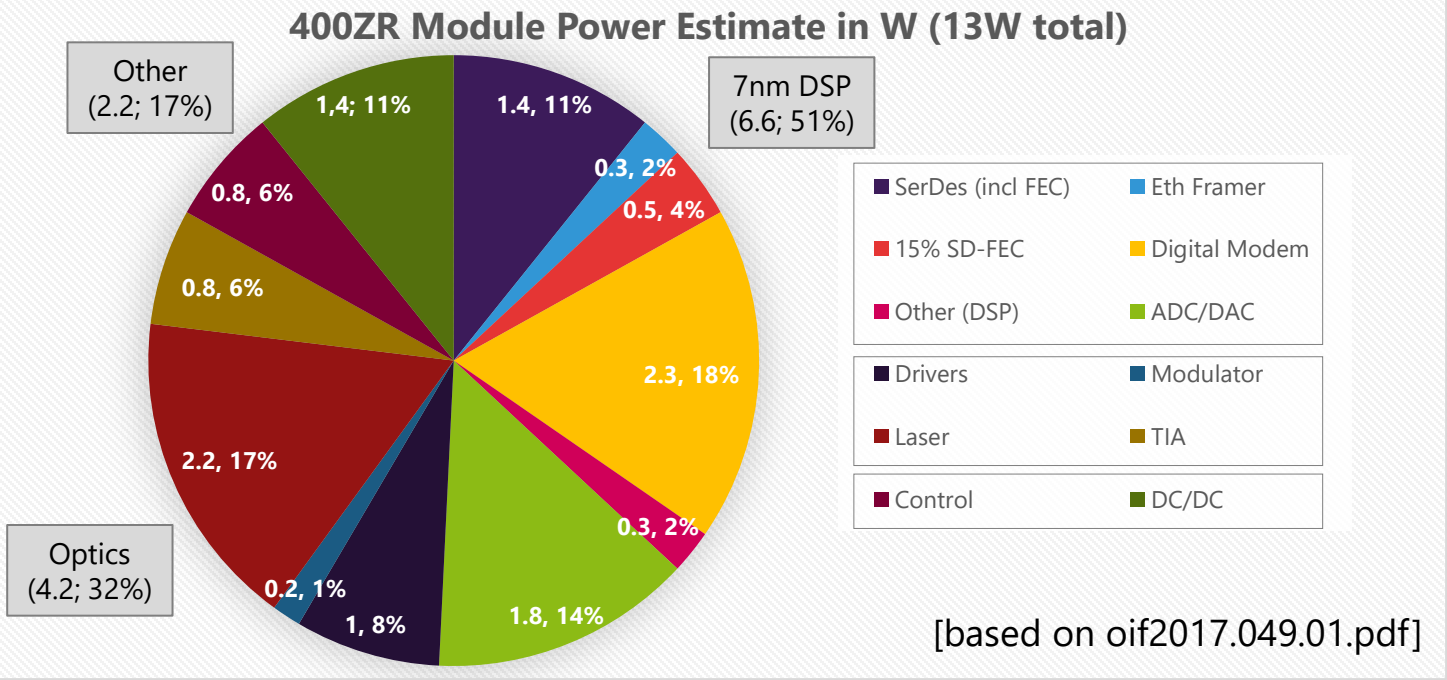
TIA: Transimpedance amplifier
TEC: Thermoelectric cooler

IC-TROSA:
Integrated coherent transmitter-receiver optical subassembly

IC-TROSA type 1 SMT package
(reflow-soldering capable)

What is important moving forward?

Low power consumption



[based on oif2017.049.01.pdf]

Need to optimize each block for shorter reach applications

Conclusions

Coherent technologies are conquering new territory

Cost, power and footprint are most important parameters in short reach applications

Spectral efficiency, ultimate performance and flexibility are less important

Near-term opportunities exist in the 100G-400G ZR(+) space

The need for higher capacities will open access and intra-DC opportunities

Thank you

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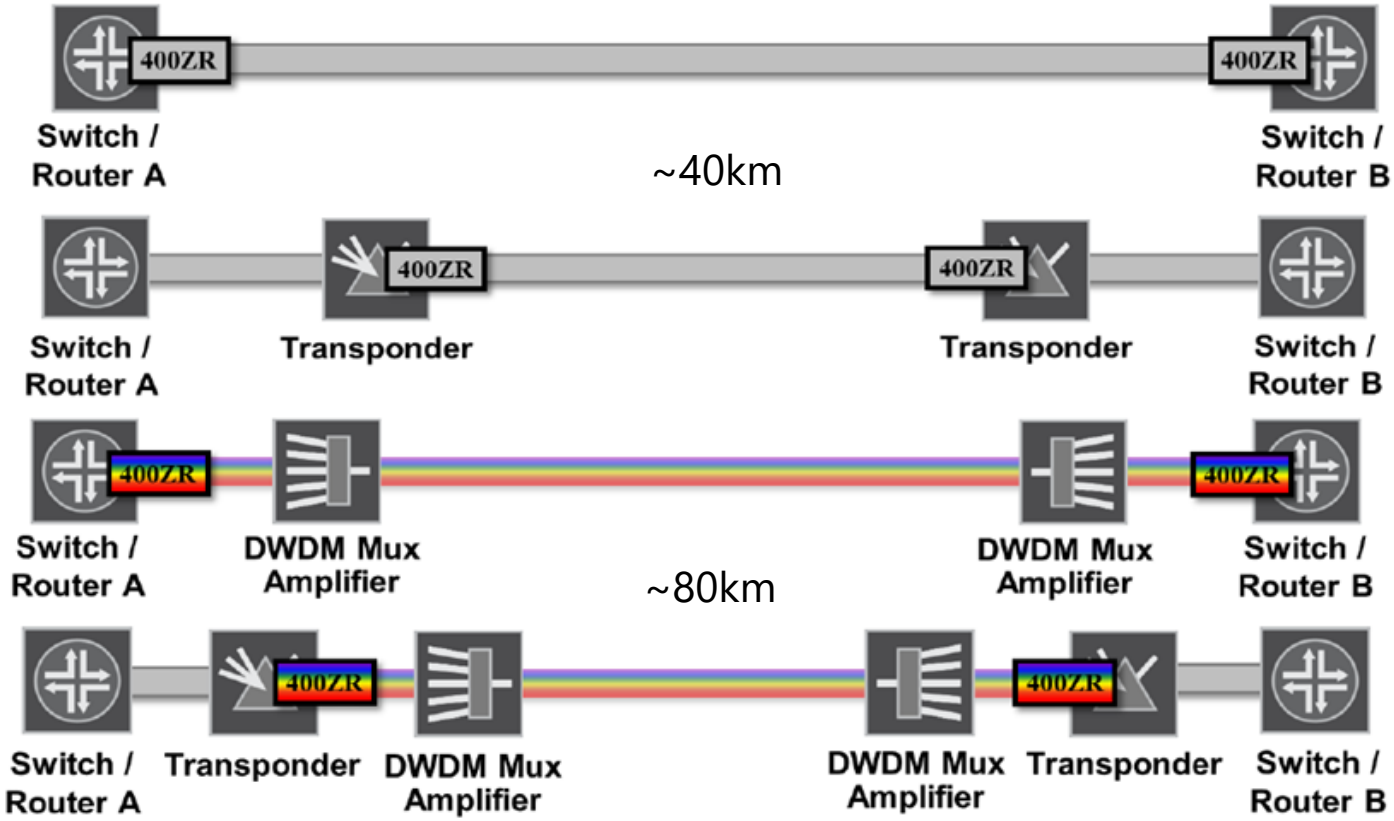
400G-ZR Data center interconnect



[adapted from: OIF-400GZR-09. Draft]

Coherent Optics for Cable Networks