



Advance Modulation of 400GE (4x100) Optical Transport

by Charlie Chen, Dr. CK Sun, Dr. Dingbo Chen

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The last mile and beyond....

Need of New Transport

addressing distance from 500m to 100km, SR-LR-ER-ZR



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Summary of Stated "Reach" Needs

Presentation	100m	500m	1km	2km	10km	40km
maki_400_01a_0513	x	x				
song_400_01_0513	x					
trowbridge_400_01_0513	x	x		x	x	x
hirai_400_01_0713					x	x
issenhuth_400_01_0713		x	x	Beyond 1km		
jewell_400_01a_0713	x (200m)	x				
nicholl_400_01_0713	←————→					
palkert_400_01_0713	x	x		x	x	x
song_400_01a_0713				x	x	
takahara_400_01_0713		x			x	x
vijn_400_01a_0713	←————→					
wenyu_400_01_0713		x		x	x	x
palkert_400_01_0913	←————→					
song_x_400_01_0913				x	x	x

Source: dambrosia_app_01_1013.

Straw poll of SMF Applications (Sep interim meeting)

I would support SMF "inside Building" reach objectives.

	Chicago Rules	Single Choice
500m	30	18
1km	13	1
2km	34	27
Undecided	11	16

I would support SMF "outside building" reach objectives.

	Chicago Rules	Single Choice
2km	10	4
Between 2km and 10km	5	0
10km	39	34
Between 10km and 40km	8	1
40km	31	11
Undecided	10	12

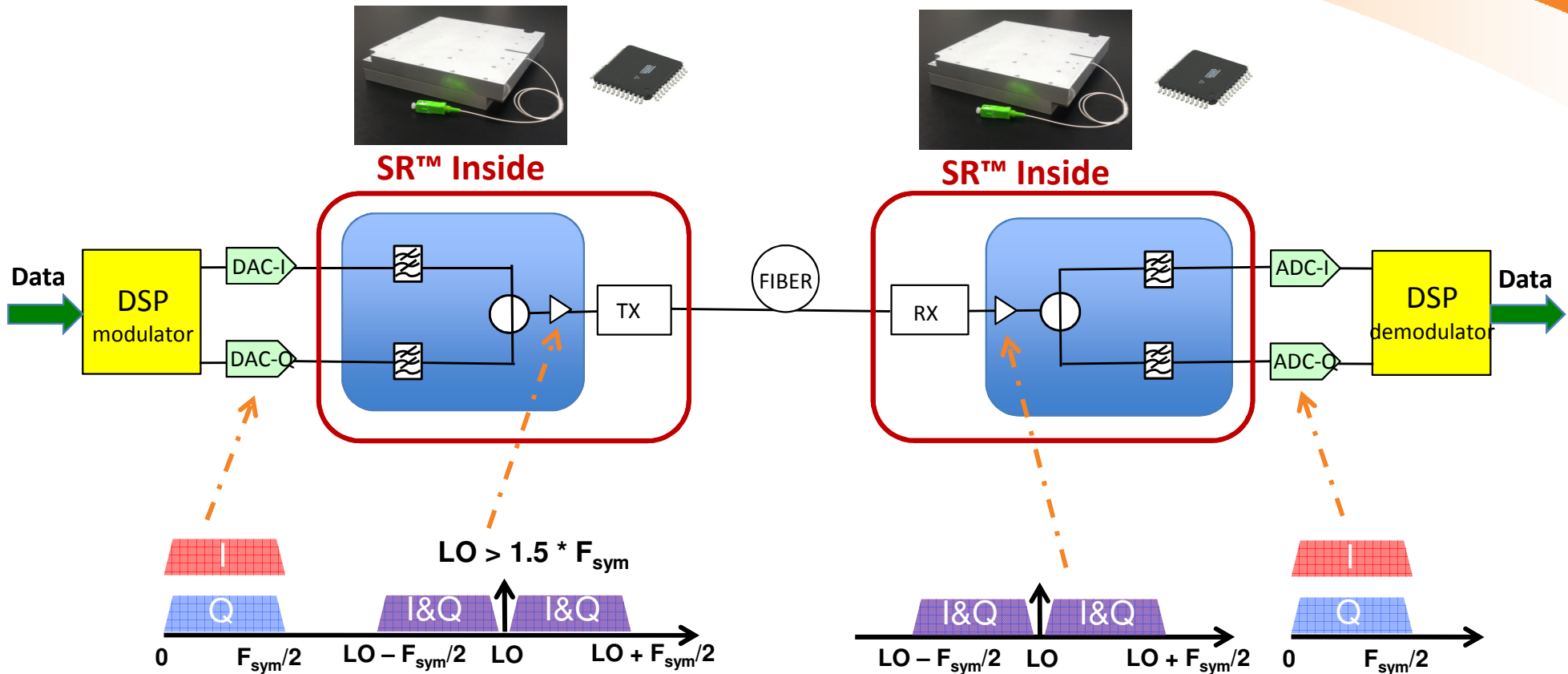
- **Sub-octave RF (SR™)** immunes to fiber dispersion induced distortions (commonly known as CSO causing high BER in modulated transport)
- SR™ provides higher transmission efficiency (4-10 bits per Hz) from advanced modulation in comparison to conventional digital transmission (1 bit per Hz)
- No complex photonics integration, or InP optical components (i.e. PBC, MZM)
- Utilization of commercially available 25G or 40G EAM lasers, to transport single lambda 100Gbps
- Proven technology in cable MSO market

SR™ Optical Transmission



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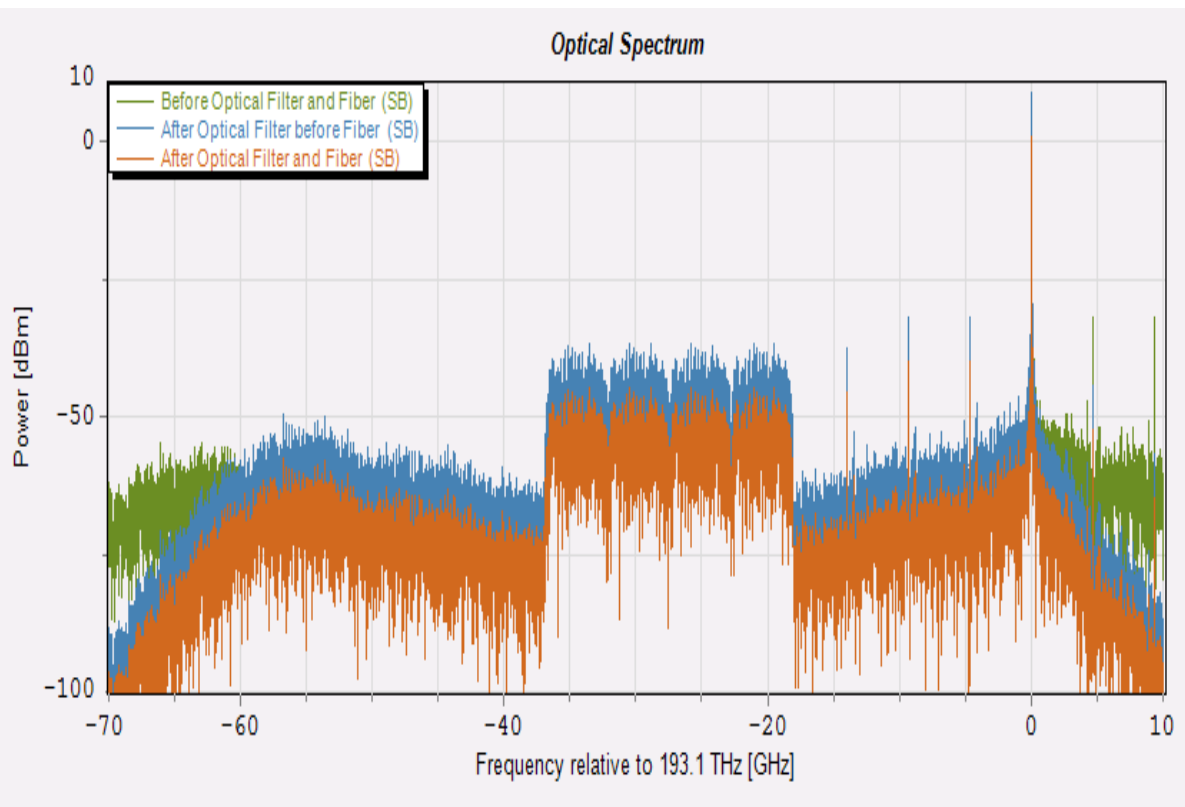
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64-QAM (6b) 40km 100Gbps/ λ



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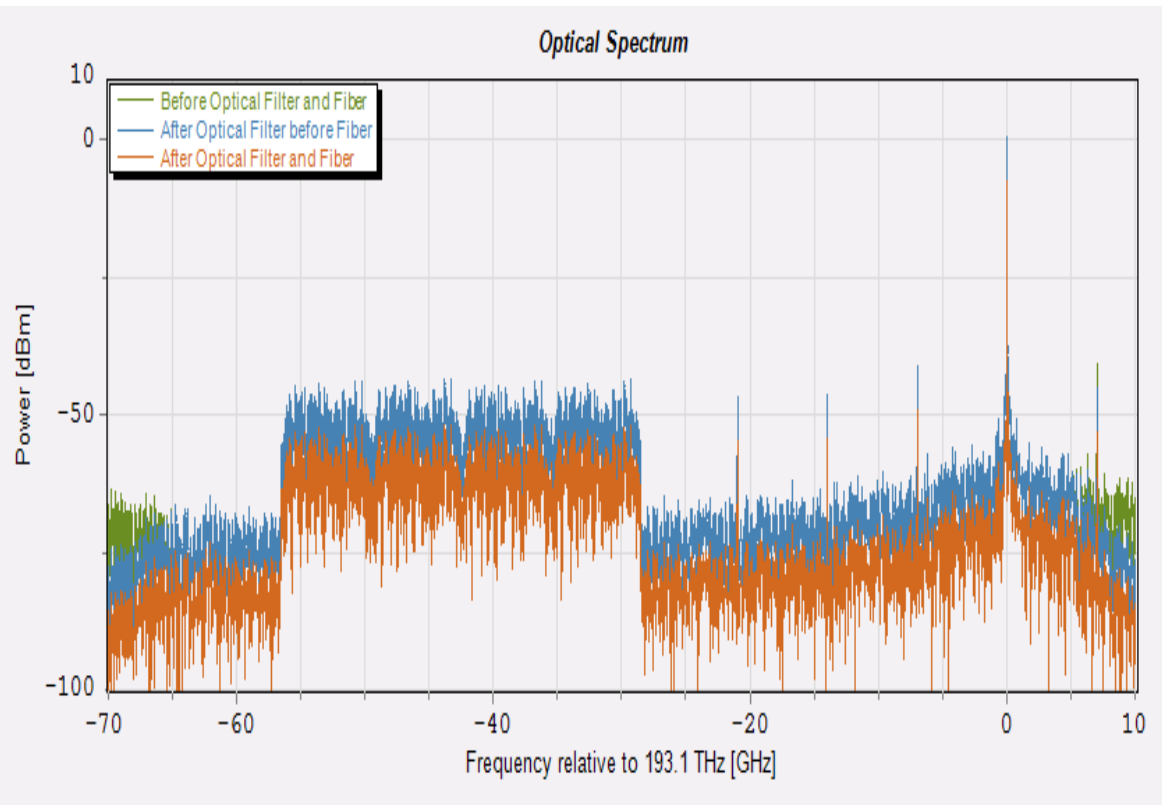
BER	Rx power -3 dBm	Rx power -6 dBm
CH1	4.0E-04	1.8E-03
CH2	1.1E-03	3.0E-03
CH3	7.5E-04	2.5E-03
CH4	6.2E-04	2.2E-03

BER at various Rx power levels
64-QAM, 40 km fiber, 1550nm, 0.25dB/km + passive loss,
+7dBm Tx power

16-QAM (4b) 40km 100Gbps/ λ



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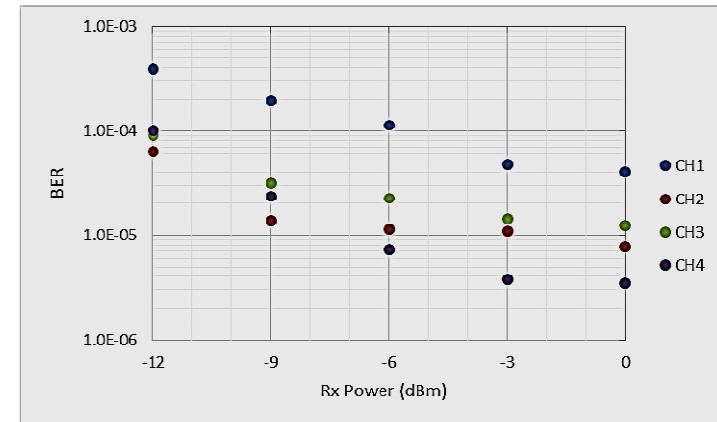
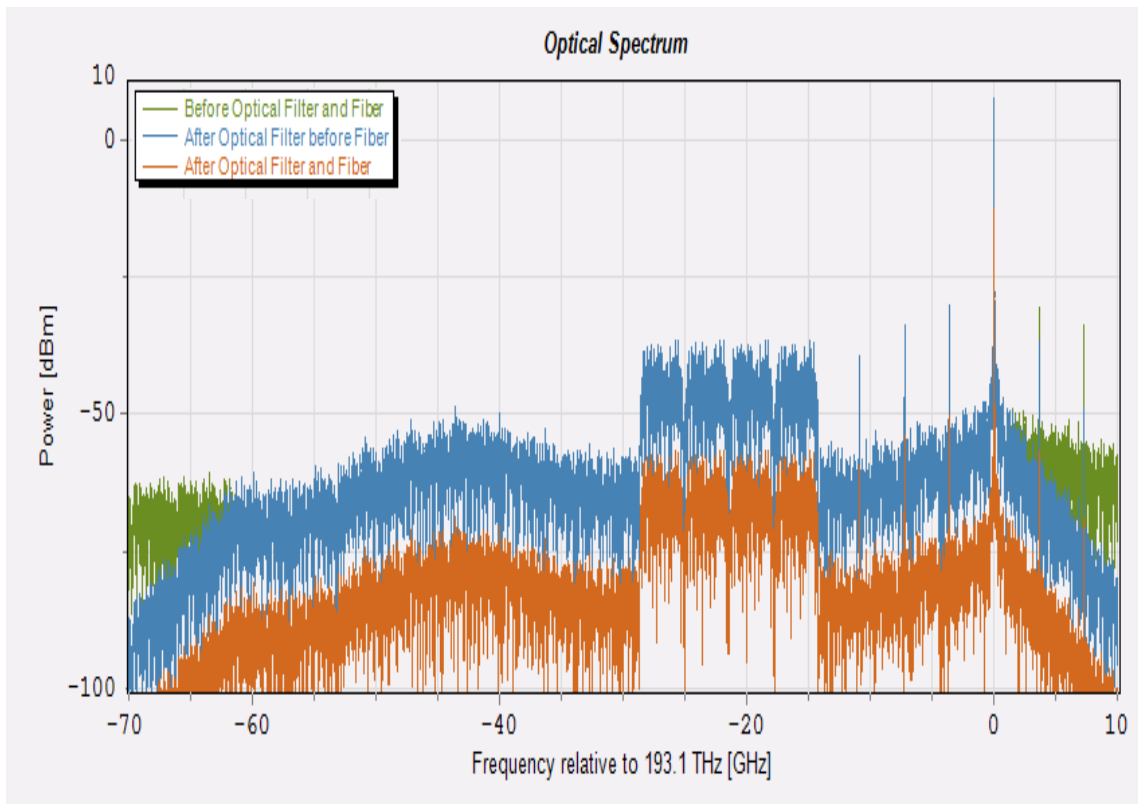


BER	Rx power -6 dBm	Rx power -10 dBm
CH1	2.5E-05	4.5E-04
CH2	8.8E-04	8.8E-04
CH3	2.5E-05	6.8E-04
CH4	1.4E-05	3.2E-04

BER at various Rx power levels

16 QAM, 40 km fiber, 1550nm, 0.25dB/km + passive loss, +7dBm Tx power

16-QAM (4b) 80km 50Gbps/ λ



BER at various Rx power levels

16 QAM, 80 km fiber, 1550nm, 0.25dB/km + passive loss,
+7 dBm Tx power,
EDFA (+10 dBm) at 40km for 80km extension

Summary

- Advanced modulation is optimized at 16- and 64-QAM for ER and ZR reach. Modulation for SR and LR distance will be presented in future study.
- SR™ enables optical transport cost effectively in longer distance, which removes the need of complex photonics integration, and/or InP optical components (i.e. PBC, MZM)
- First target of 400G (4x100) in CFP and CFP2 form factor at ER and ZR reach. SR and LR is projected to follow in CFP4 and/or QSFP form factor.

Thank you!

Please contact Charlie Chen for further questions