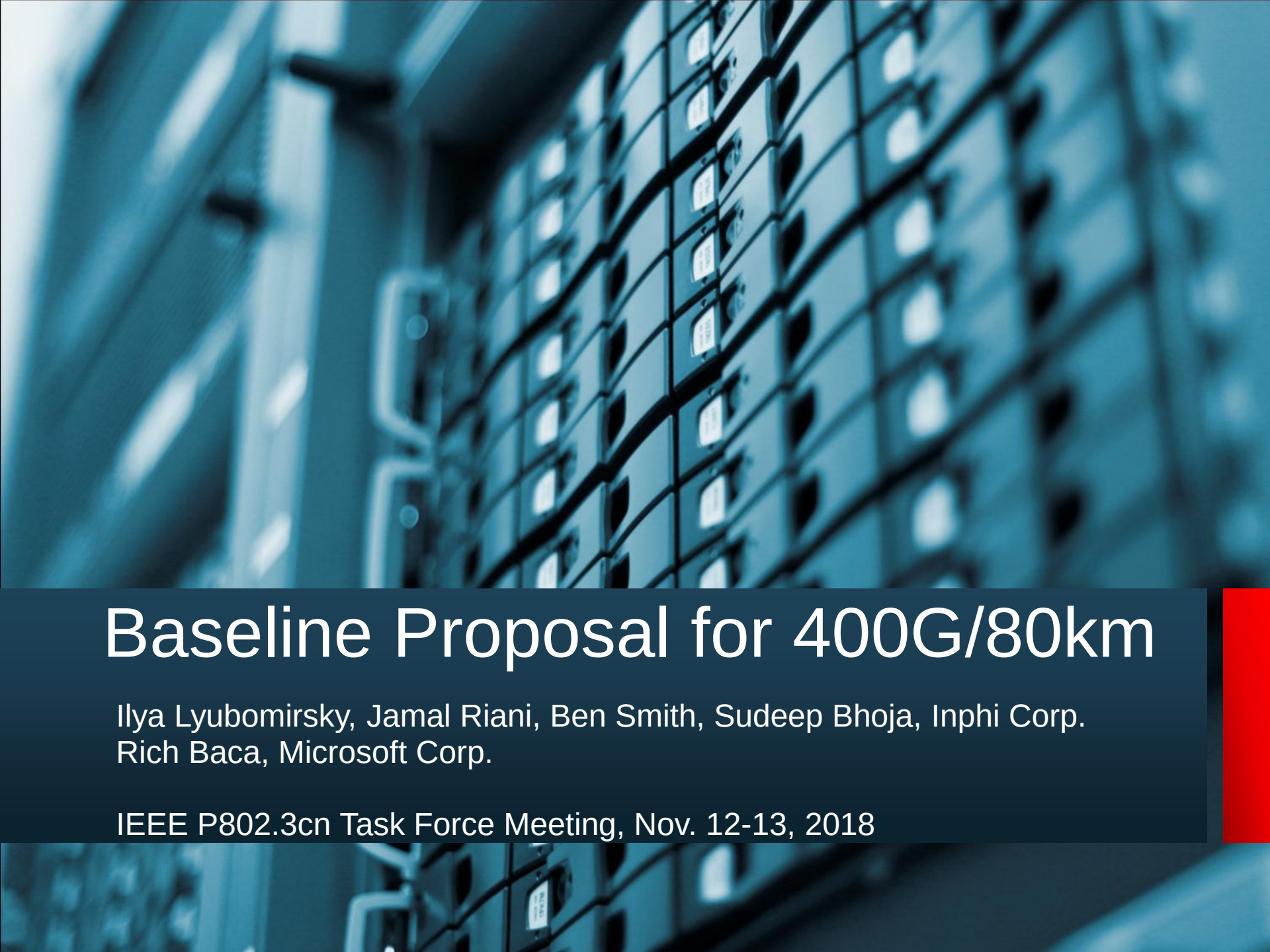

Baseline Proposal for 400G/80km

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Rich Baca, Microsoft Corp.

IEEE P802.3cn Task Force Meeting, Nov. 12-13, 2018

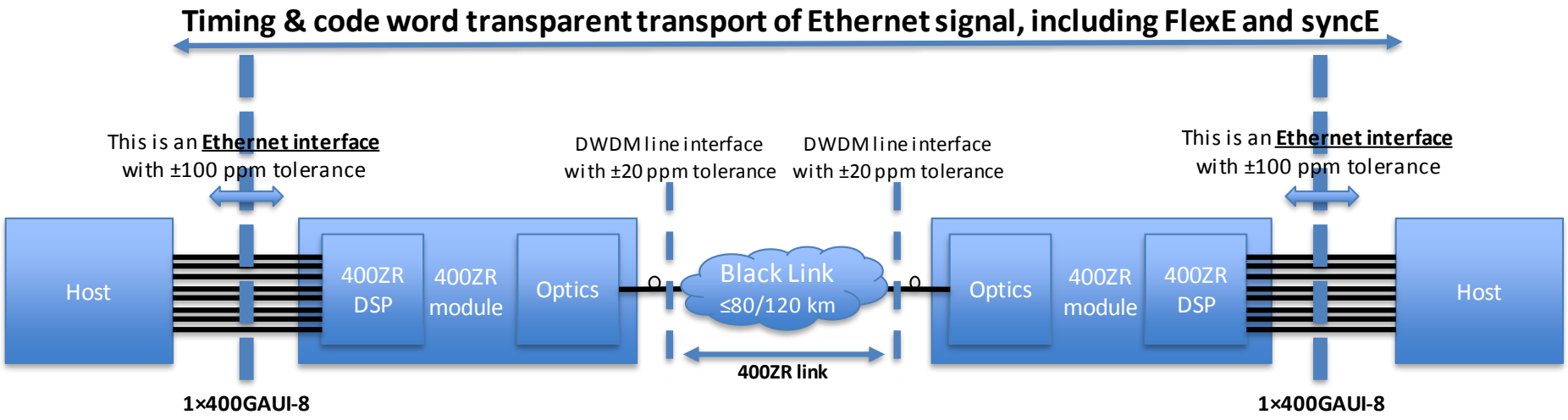
Supporters

- Brad Booth, Microsoft
- Jean-Michel Caia, Fiberhome
- Frank Chang, Source Photonics
- James Chien, ZTE
- Ryan Yu, Molex
- Winston Way, Neophotonics

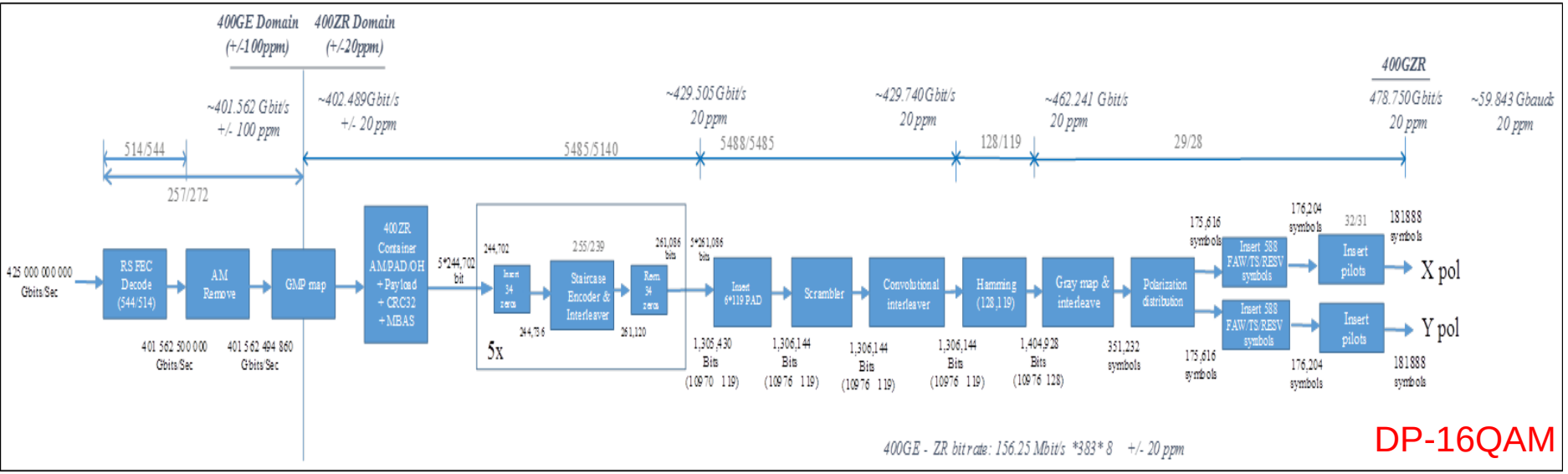
Outline

- OIF 400ZR draft specs. expected to be provided by OIF to IEEE 802.3cn via a liaison letter
- Link budget analysis in lyubomirsky_3cn_01_1118 confirms OIF 400ZR Tx/Rx power and OSNR specs. provide a good starting point for 400Gb/s over 80km objective
- In this presentation, we outline a baseline proposal for 400Gb/s over 80km based on OIF 400ZR IA

400ZR Reference Diagram



400ZR Data Path and Rates

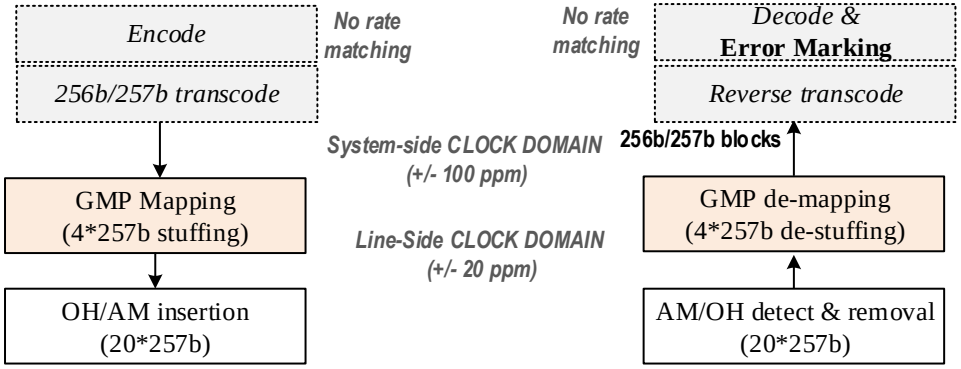


DP-16QAM

Baud Rate
59.84 Gbaud

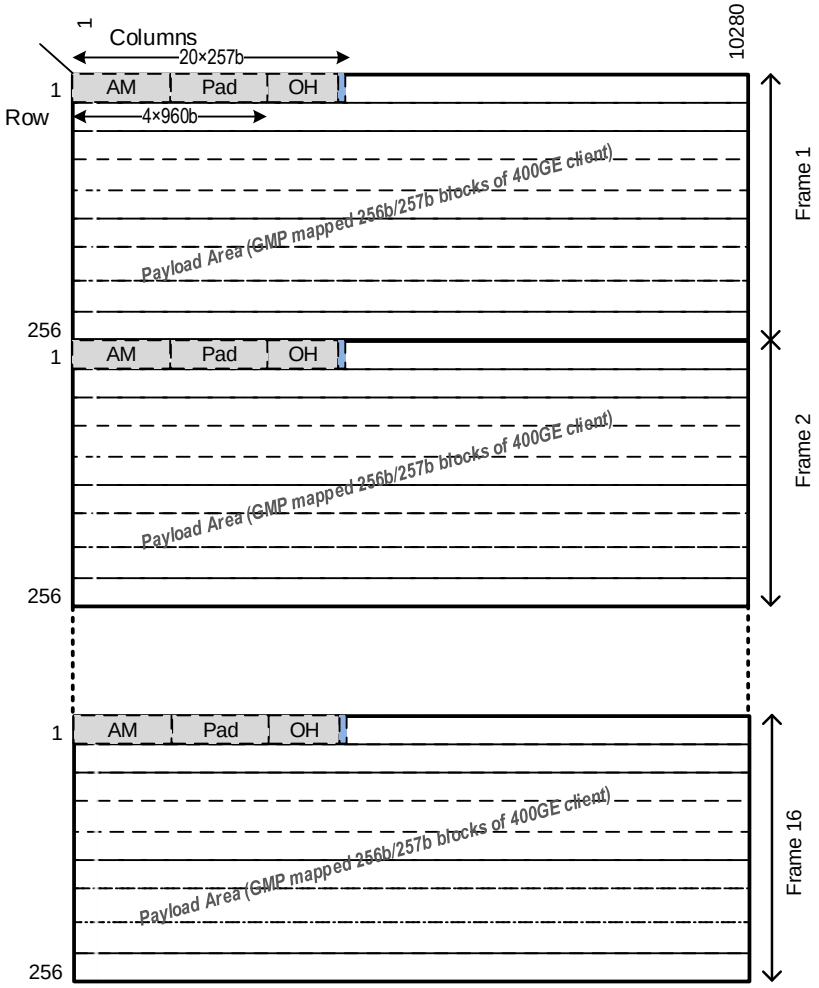
See OIF 400ZR IA draft for detailed description of each block

GMP Mapping to 400ZR Frame



- 400GE signal is mapped to a 400ZR frame as a 256/257 block stream
- GMP mapping (4x257b) is used to rate-adapt payload to local reference with +/- 20ppm clock accuracy

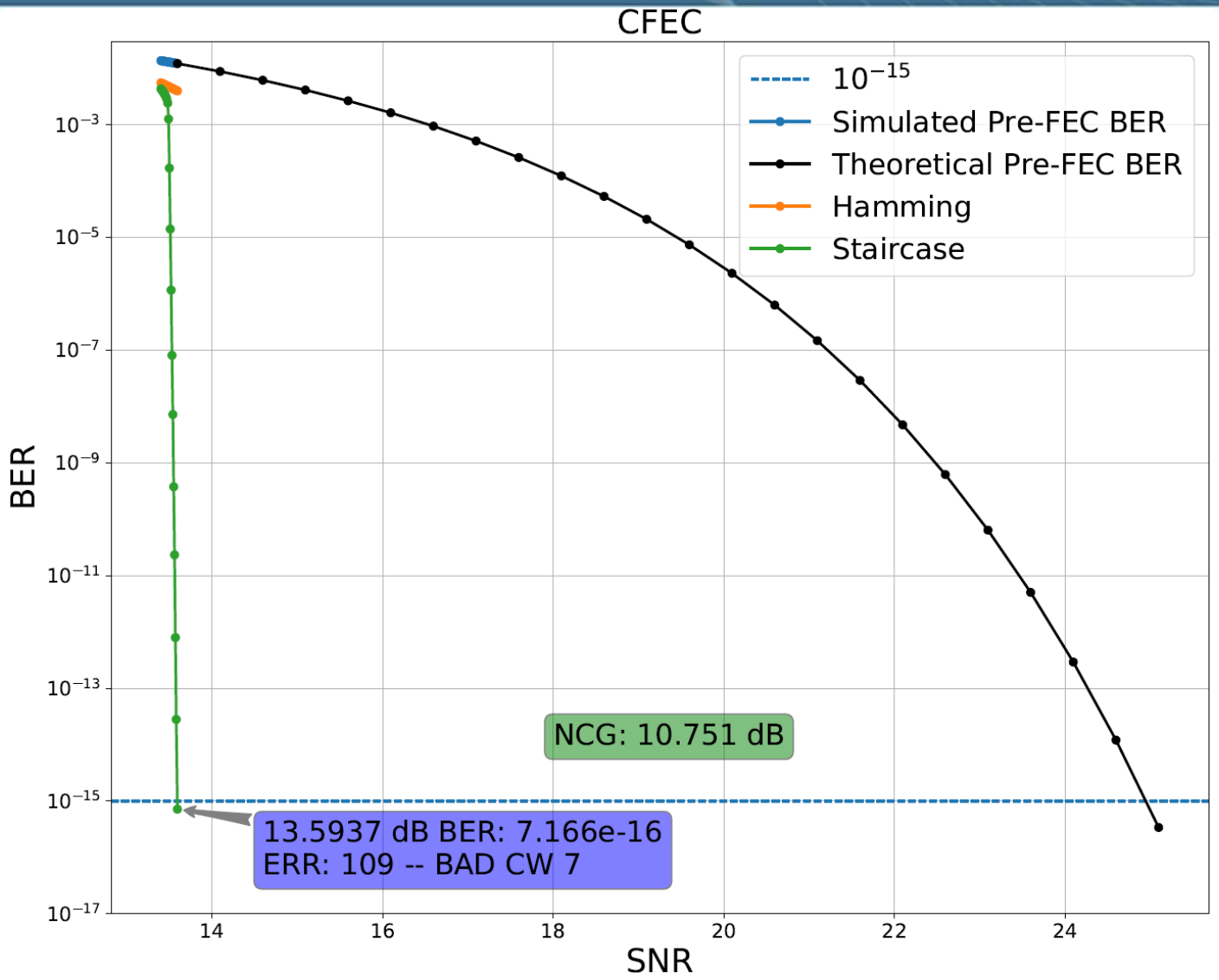
400ZR Frame Structure



OIF 400ZR FEC (CFEC)

- Concatenated FEC
- Soft decision inner – Hamming (128,119) Code
- Hard decision outer – Staircase Code (255,239)
- NCG = 10.8dB (16QAM)
- FEC overhead = 14.8 %
- Ultra Low Power = 420 mW (7nm, 400G)
- Burst Tolerance = 1024 bits
- Latency = 4 μs (400G)

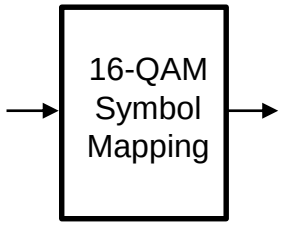
Inphi FPGA Emulation Results

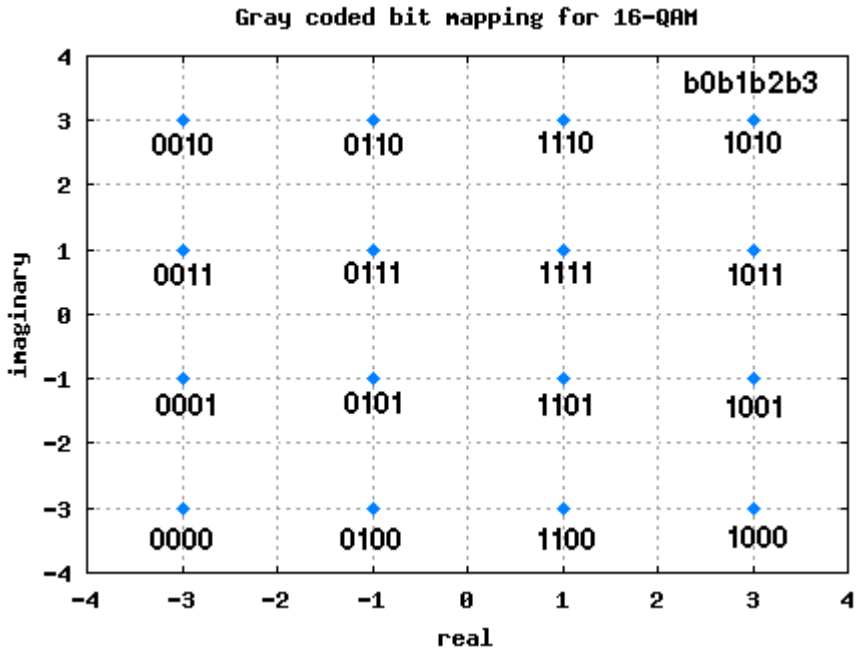


See also independent ZTE results: OIF2018.136.00, “FPGA Verification of Concatenated Staircase and Hamming Code for 400ZR FEC”

16-QAM Symbol Mapping

100110101000…

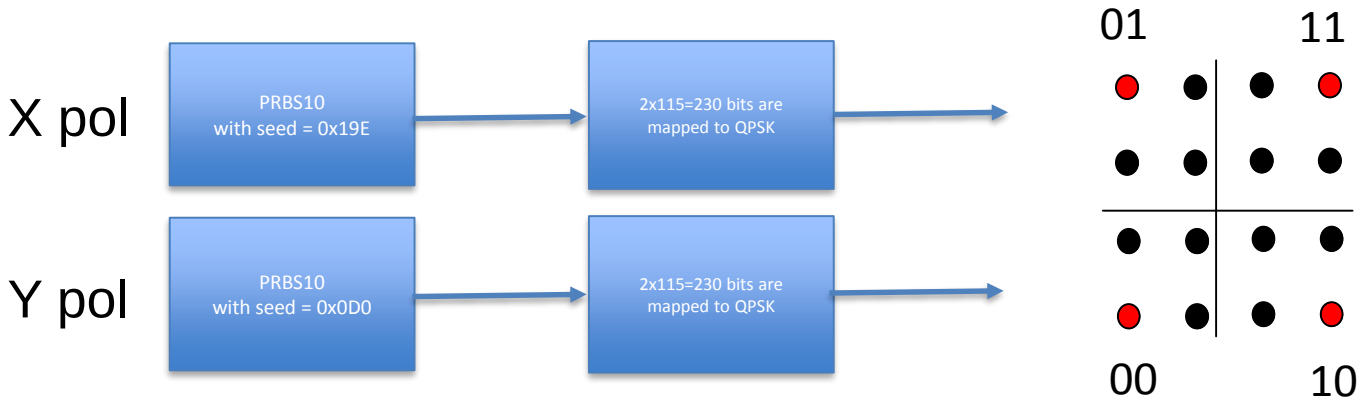




- Bits are Grey mapped to 16-QAM symbols
- 16-QAM Symbols are interleaved and distributed to X and Y polarizations

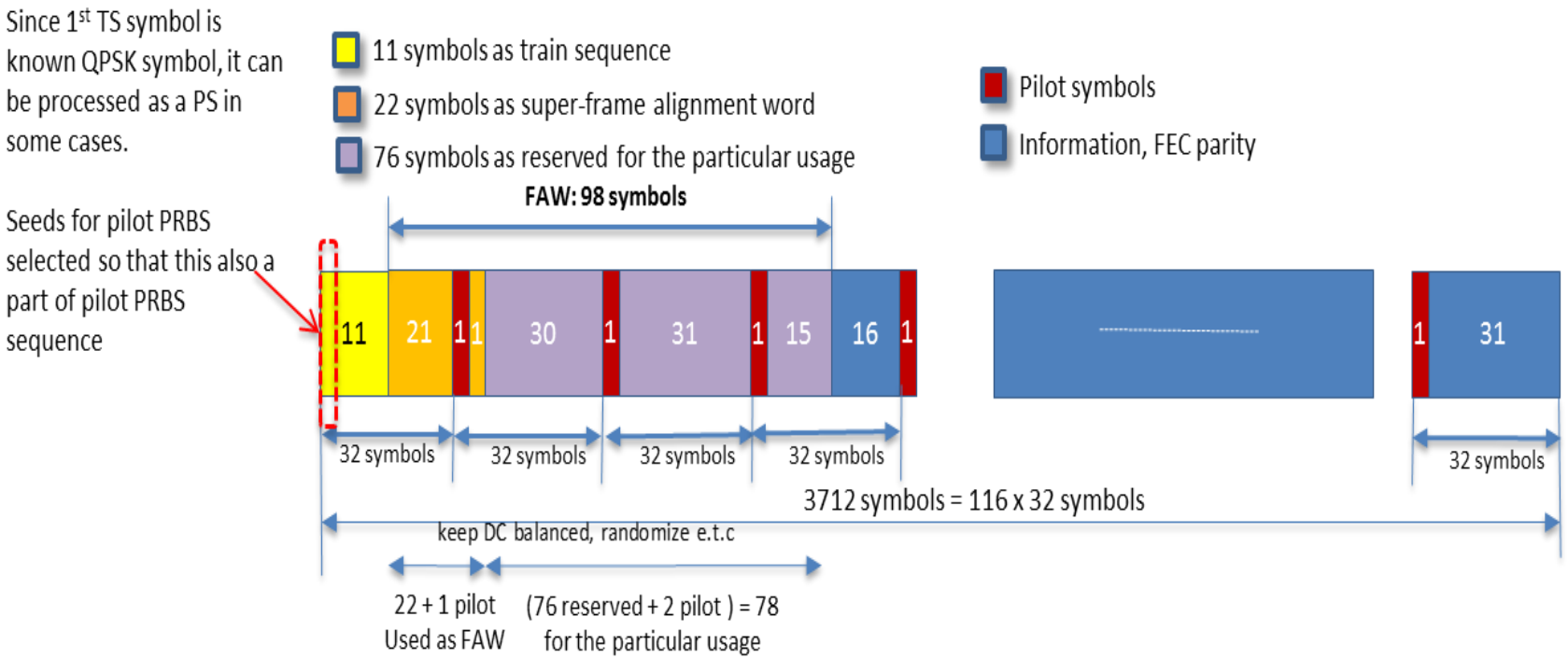
Pilot Symbols

Pilot symbols are added periodically to aid Rx DSP carrier phase recovery and enable absolute phase detection for better performance



- Pilot symbol inserted with a period of 32 QAM symbols
- Different pilot sequences used for X and Y polarizations

DSP Frame Overview



- A DSP frame consists of 3712 symbols; 49 DSP frames are combined into a Super Frame structure in each X/Y polarizations
- Each DSP frame includes an 11 symbol training sequence, and pilot symbols inserted every 32 symbols
- First DSP frame includes a 22 symbol Super Frame Alignment Word (FAW), different for X/Y polarizations, and 76 reserved symbols

400ZR Key Tx Optical Specs.

Parameter	Min	Max	Unit	Conditions/Comments
Channel frequency	191.3	196.1	THz	ITU-T grid
Channel Spacing	100		GHz	Per ITU-T G694.1 Section 6.
Optical Output Power	-10	-6	dBm	Amplified DWDM links up to 80 km
Laser frequency accuracy	-1.8	1.8	GHz	Offset from channel frequency set point. The receiver LO is expected to have same frequency accuracy
Laser linewidth		500	KHz	FWHM (-3dB), high frequency component of phase noise. May need to add small OSNR penalty.
Laser RIN		-140	dB/HZ	0.2GHz ≤ f ≥ 10GHz - Avg
		-130		0.2Ghz ≤ f ≥ 10Ghz - Peak
I-Q amplitude imbalance		1	dB	
I-Q phase imbalance	-5	+5	degrees	

See OIF 400ZR IA draft for complete list of Tx specs.

400ZR Key Rx Optical Specs.

Parameter	Min	Max	Unit	Conditions/Comments
Frequency offset between RX and LO	-3.6	+3.6	GHz	Acquisition Range
Input power range	-12	0	dBm	Signal power of the channel at the OSNR performance defined in 13.3.30
Input sensitivity	-12		dBm	At CFEC threshold when RX OSNR > 26 dB
OSNR Tolerance		26	dB	At CFEC threshold BER = 1.25e-2
CD Tolerance	1600		ps/nm	Tolerance to Chromatic Dispersion (80 km). Note reduced from 2400 ps in OIF spec.
Optical path power penalty		0.5	dB	OSNR tolerance penalty over due to reflections and the combined effects of dispersion resulting from ISI
PMD tolerance	10	-	ps	Tolerance to PMD with ≤0.5 dB penalty to OSNR sensitivity
Peak PDL tolerance	2.5	-	dB	Tolerance to PDL with ≤0.8 dB penalty to OSNR sensitivity. May be increased to 3.5 dB.
Tolerance to change in SOP	50	-	rad/ms	Tolerance to change in SOP with ≤0.5dB penalty to OSNR sensitivity.

See OIF 400ZR IA draft for complete list of Rx specs.

Conclusions

- Outlined a baseline proposal for 400Gb/s over 80km objective, including FEC, Framing, Modulation, and Tx/Rx optical specs
- Proposal is based on OIF 400ZR IA draft specs. to be provided in OIF liaison letter
- Test metrics, such as Tx EVM measurement, need to be developed to supplement the OIF IA specs.