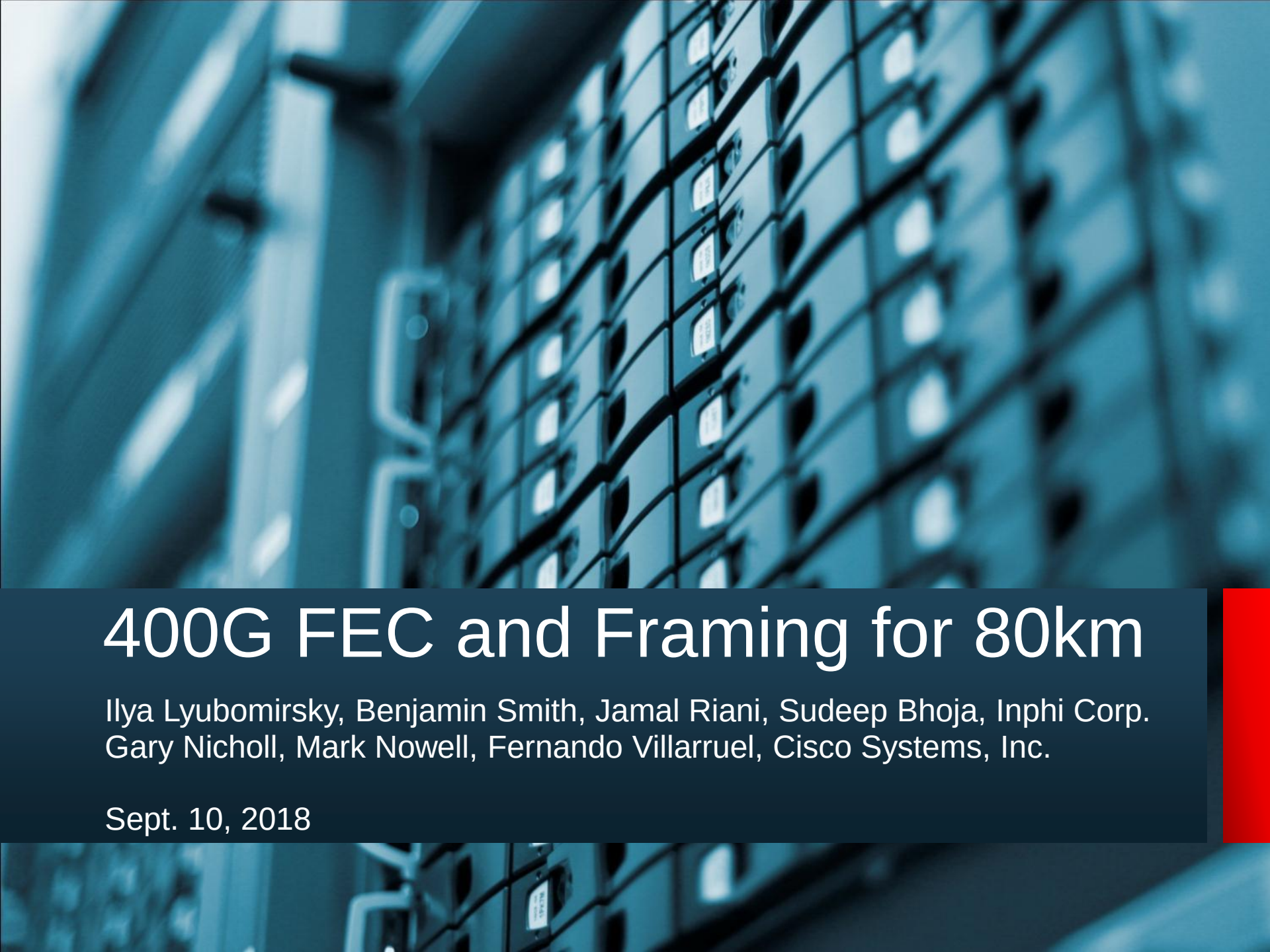


400G FEC and Framing for 80km

Ilya Lyubomirsky, Benjamin Smith, Jamal Riani, Sudeep Bhoja, Inphi Corp.
Gary Nicholl, Mark Nowell, Fernando Villarruel, Cisco Systems, Inc.

Sept. 10, 2018

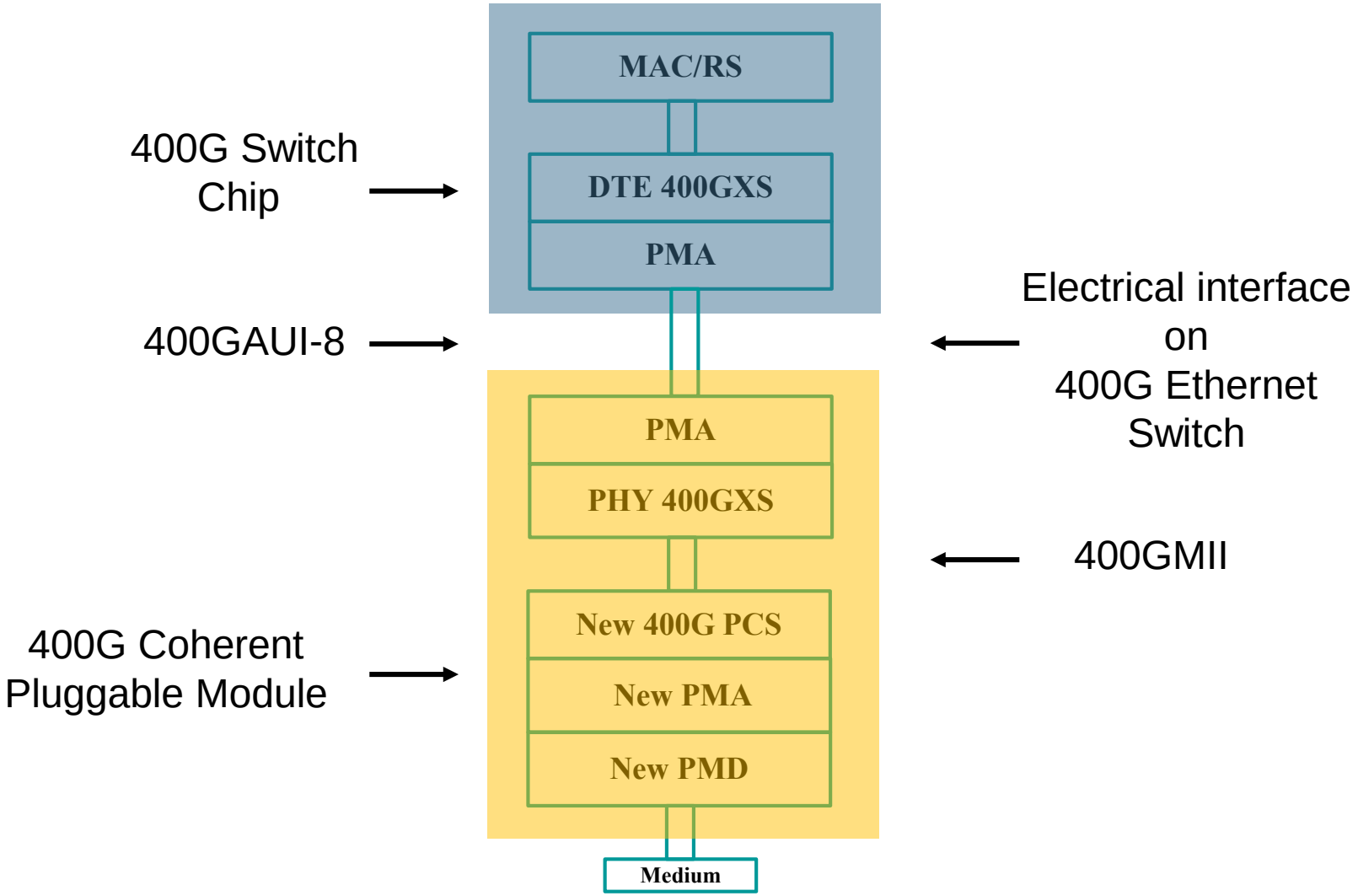
Supporters

- Jean-Michel Caia, Fiberhome
- Rich Baca, Microsoft
- Paul Brooks, Viavi Solutions
- James Chien, ZTE
- Tad Hofmeister, Google
- Steve Trowbridge, Nokia

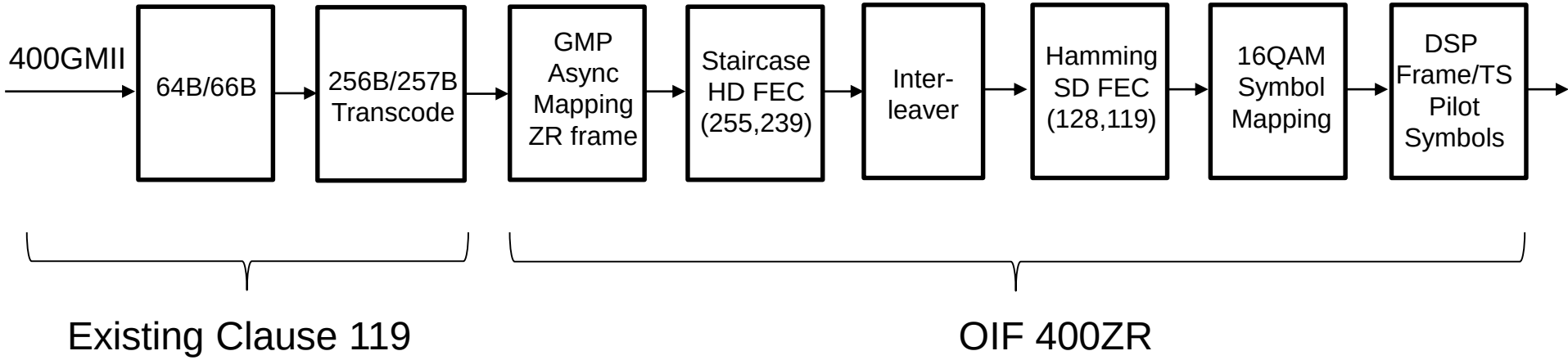
Goals for 400G FEC and Framing

- Enable low power FEC for pluggable modules with sufficient coding gain for 80km reach
- Leverage FEC+Framing developments in OIF 400ZR
- Leverage industry coherent ASIC technology developments to minimize costs

IEEE Layer View

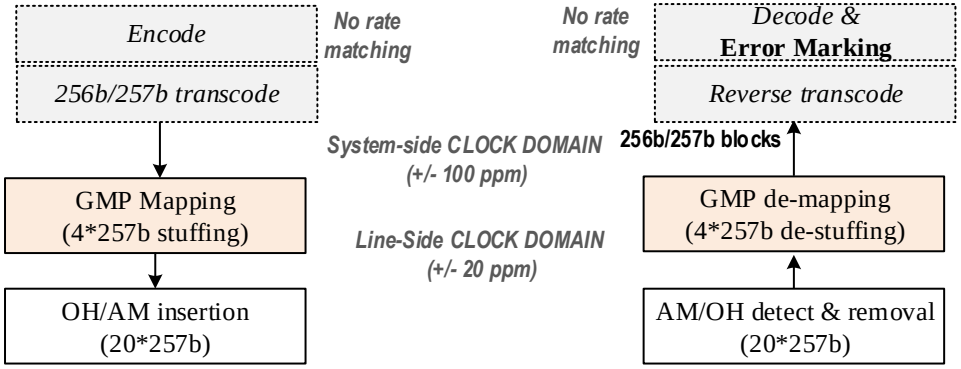


OIF 400ZR FEC+Framing



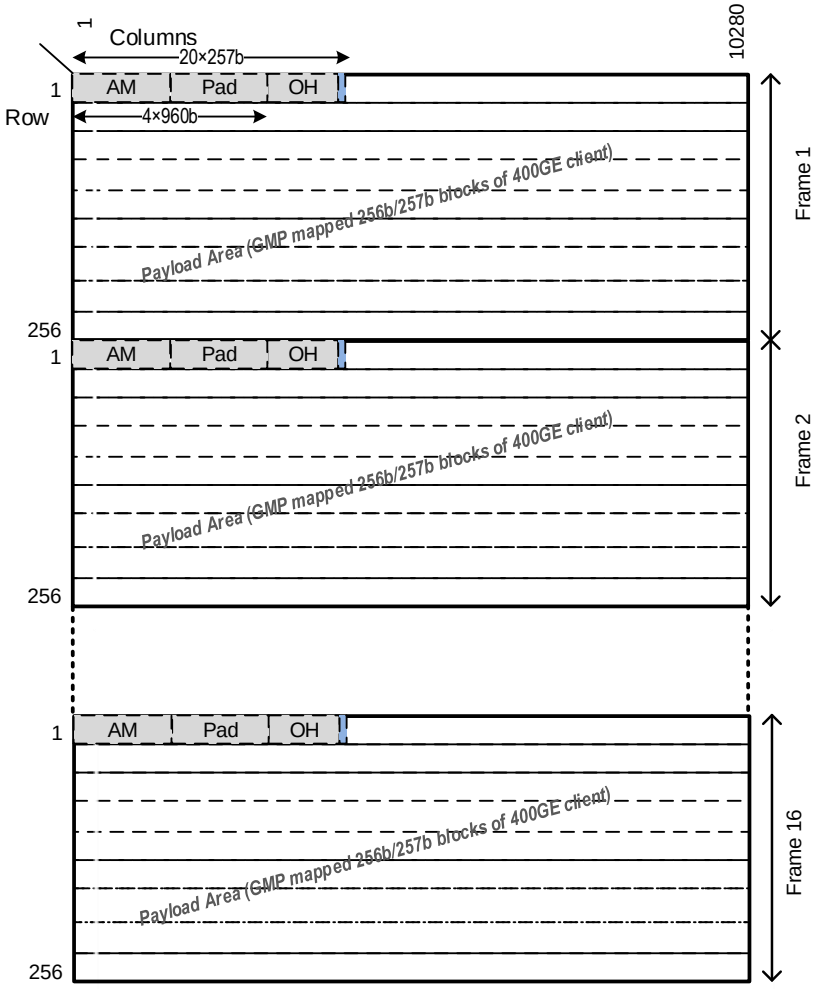
- Reuse significant amount of 802.3bs PCS (Clause 119)
- Leverage FEC and DSP framing from OIF 400ZR project

GMP Mapping to 400ZR Frame

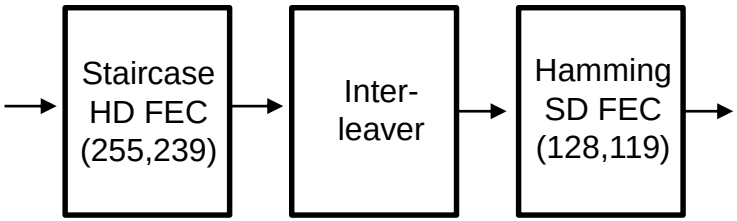


- 400GE signal is mapped to a 400ZR frame as a 256/257 block stream
- GMP mapping (4x257b) is used to rate-adapt payload to local reference with +/- 20ppm clock accuracy

400ZR Frame Structure



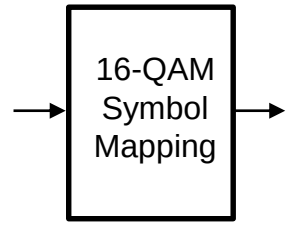
OIF 400ZR FEC (CFEC)

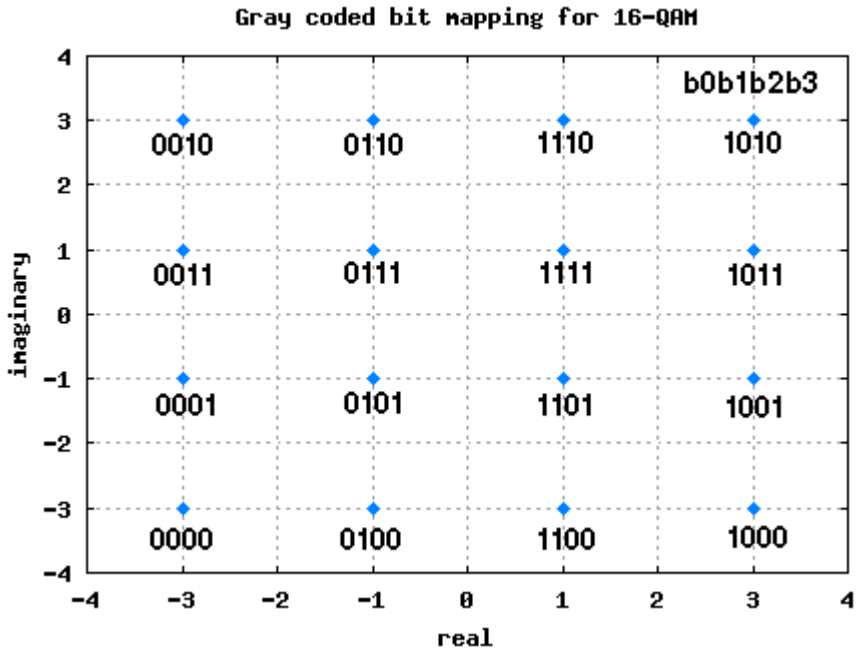


- Concatenated FEC
- Soft decision inner – Hamming (128,119) Code
- Hard decision outer – Staircase Code (255,239)
- NCG = 10.8dB (16QAM)
- FEC overhead = 14.8 %
- Ultra Low Power = 420 mW (7nm, 400G)
- Burst Tolerance = 1024 bits
- Latency = 4 μs (400G)

16-QAM Symbol Mapping

100110101000…

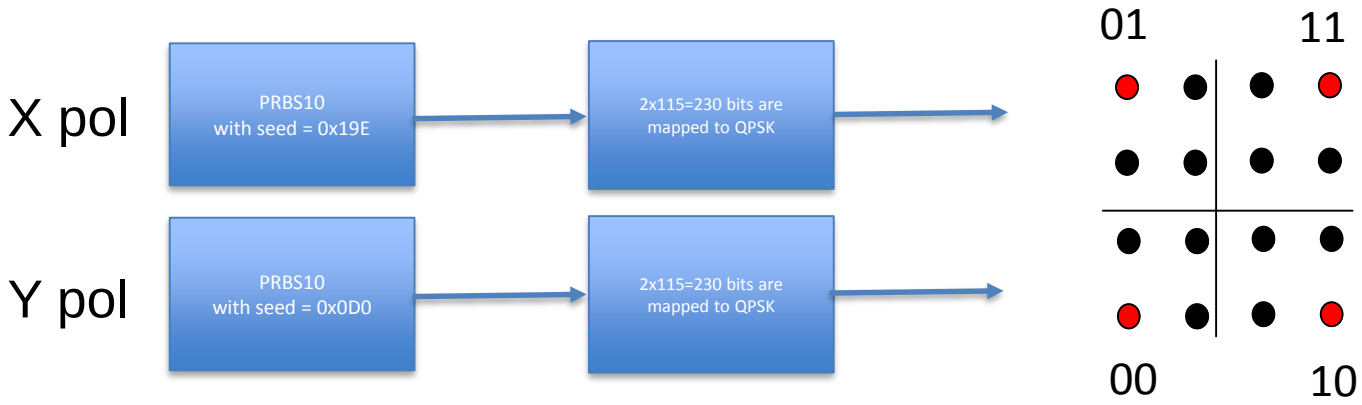




- Bits are Grey mapped to 16-QAM symbols
- 16-QAM Symbols are interleaved and distributed to X and Y polarizations

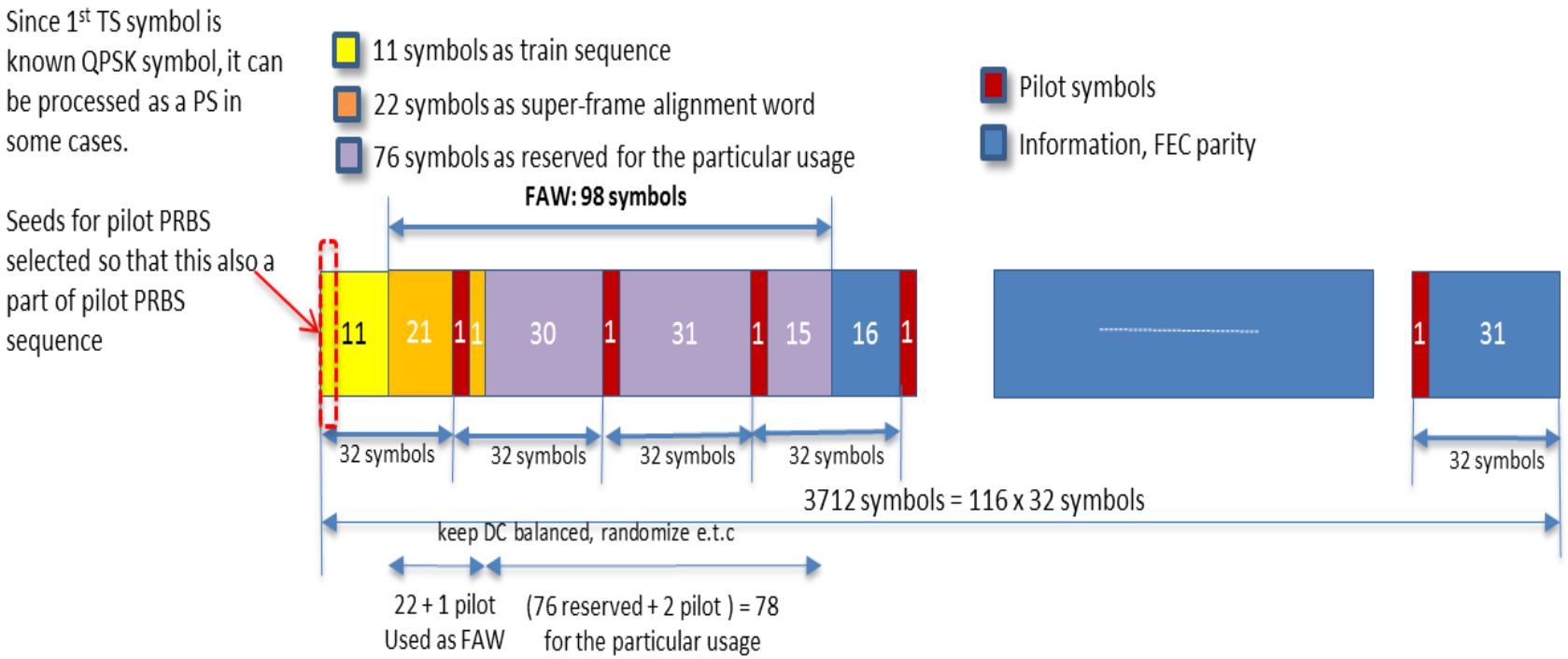
Pilot Symbols

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

Conclusions

- Provided overview of OIF 400ZR FEC and Framing
- Recommend leveraging the work of OIF 400ZR for B10K 400G/80km