

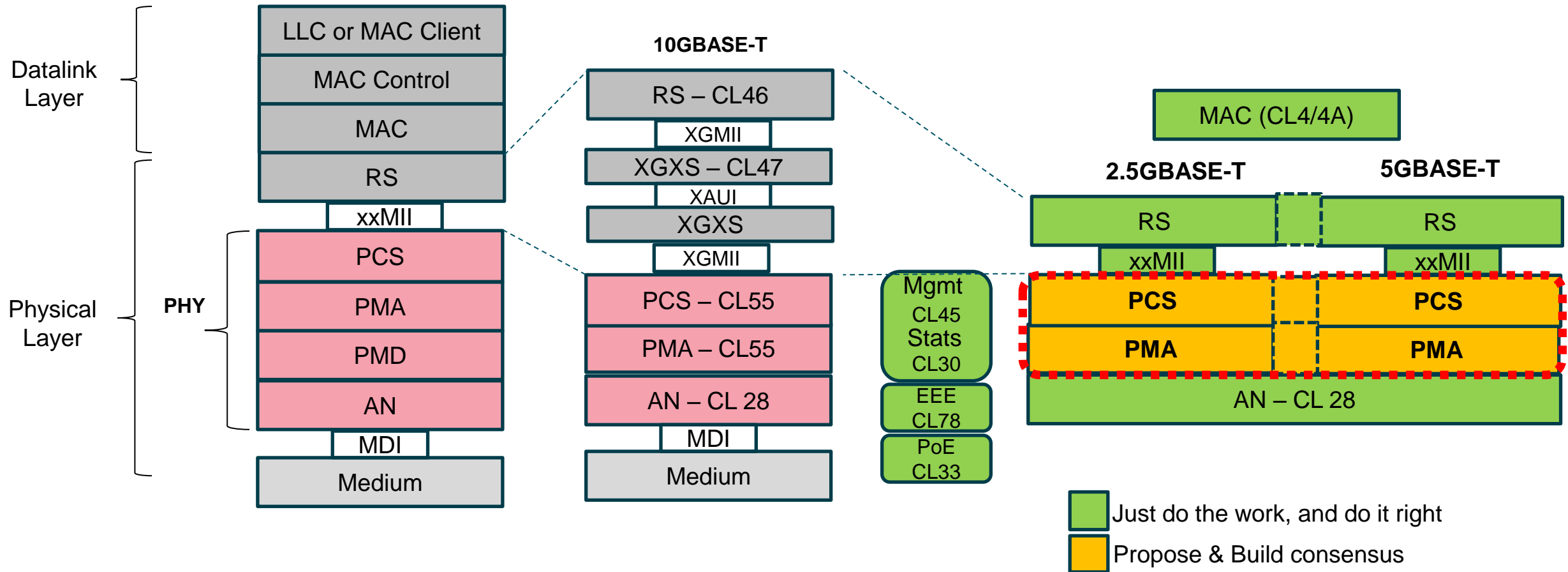
802.3BZ 2.5G/5GBASE-T TF

PCS/PMA PROPOSAL



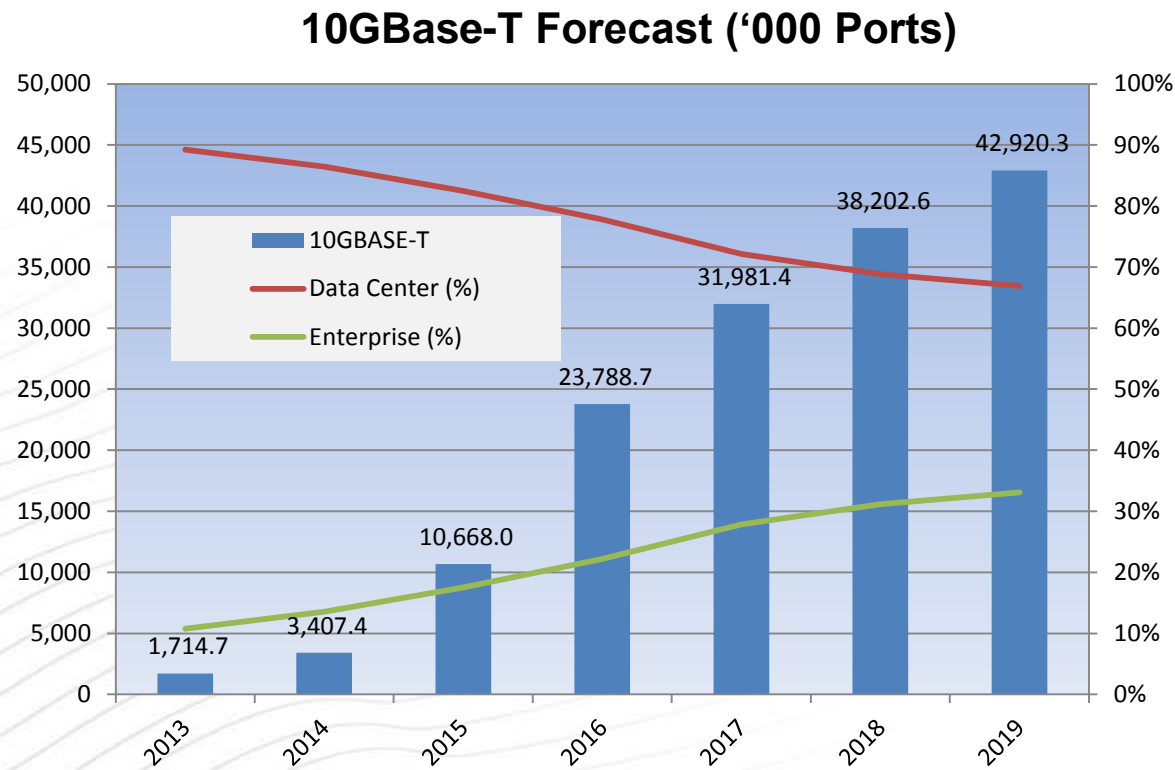
**Tom Souvignier
German Feyh
May 2015 – IEEE 802.3 Interim – Pittsburgh**

2.5G and 5G BASE-T Layering considerations



10GBASE-T MARKET – SIGNIFICANT GROWTH

- 10GBase-T market doubled in 2014 (from 2013)
- Expected to grow to >40M by 2019
- 1/3 of all ports will be shipped for the enterprise by 2019

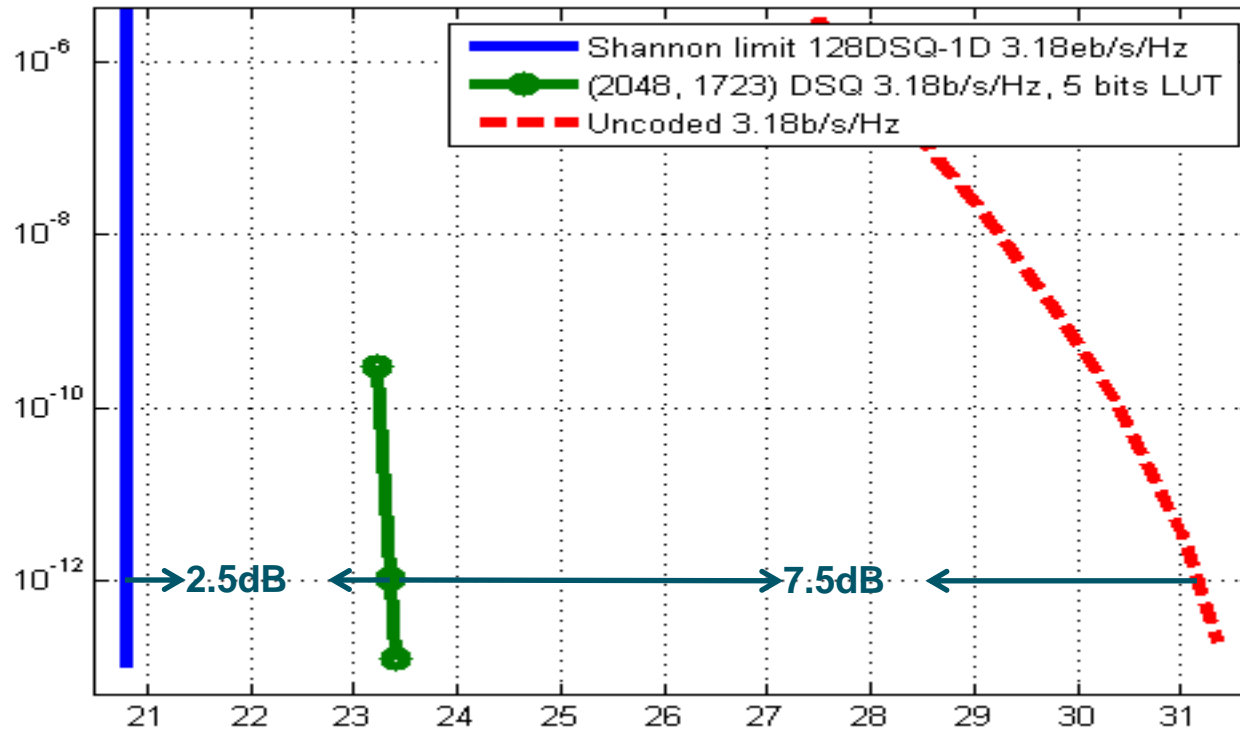


Source: Dell'Oro Feb'15

- **Hockey stick growth in Enterprise & Data Center environments**
- **10GBASE-T operates successfully in Enterprise & Data Center environments**
- **Use and knowledge of 10GBASE-T is widely disseminated:**
 - 10GBASE-T standard was approved in June 2006.
 - Three generations in the field: 65nm, 40nm and 28nm.
 - Multi-vendor interoperability well established.
- **Due to 10GBASE-T's success, an amendment to IEEE Std 802.3 (802.3bq) is under way for:**
 - 25G
 - 40G
- **Scaling the 10GBASE-T standard is a fast and sure path to a 2.5/5GBASE-T standard.**

- **DSQ-128 and (2048,1723) LDPC**

- 10GBASE-T is a performance optimized transmission standard less than 2.5dB from Shannon capacity



FREQUENCY-SCALED 10GBASE-T FULL DUPLEX TRANSMISSION

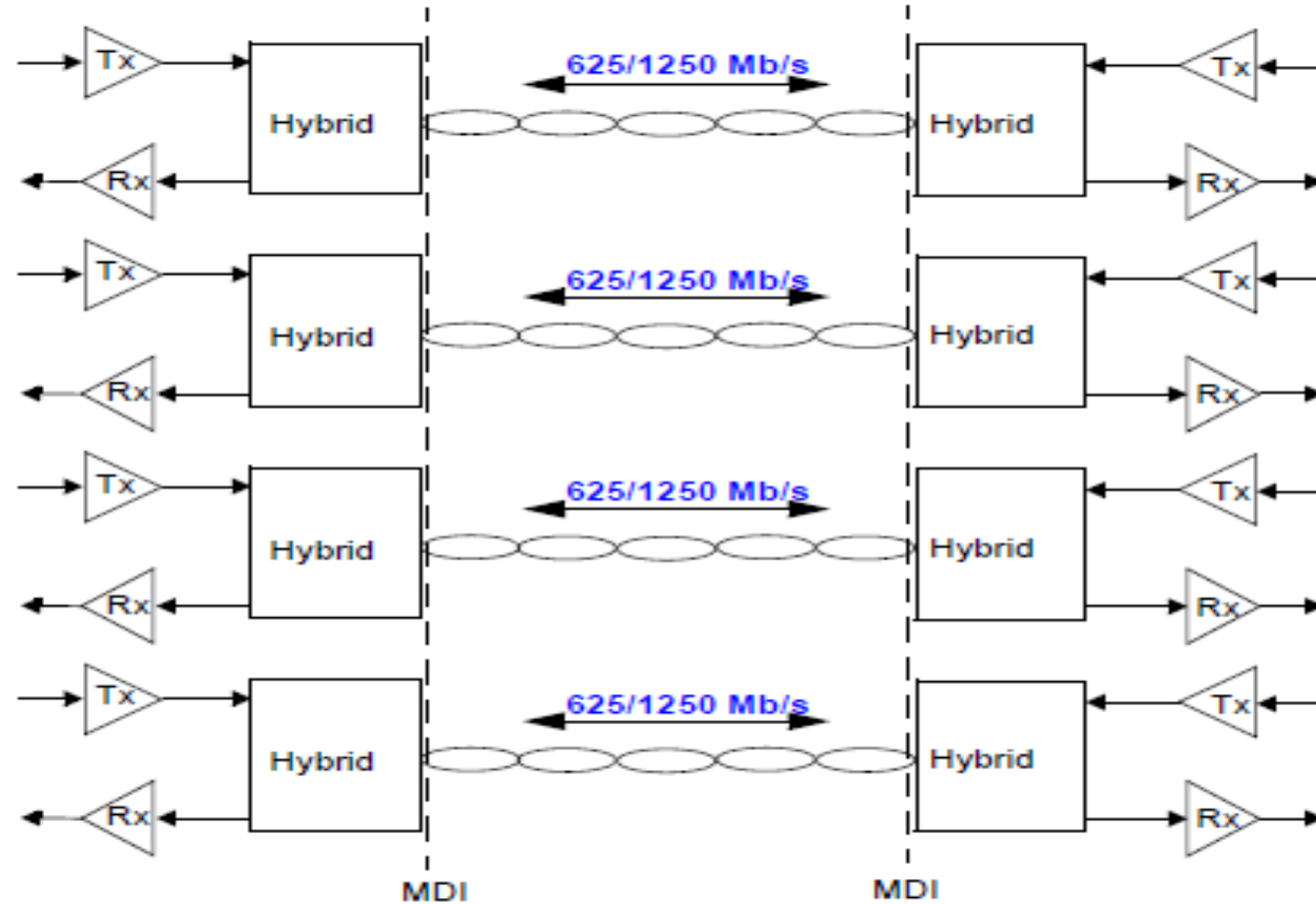
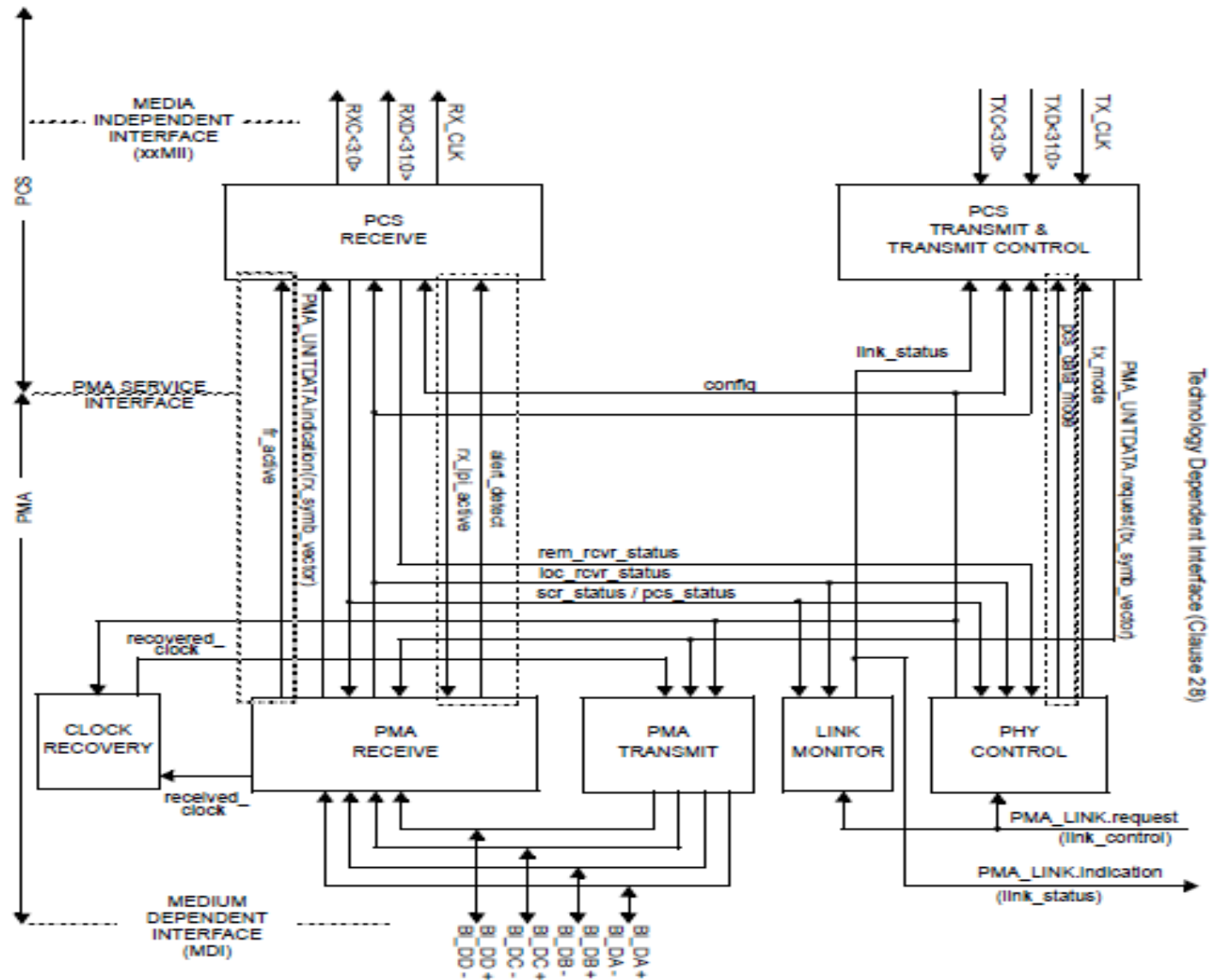


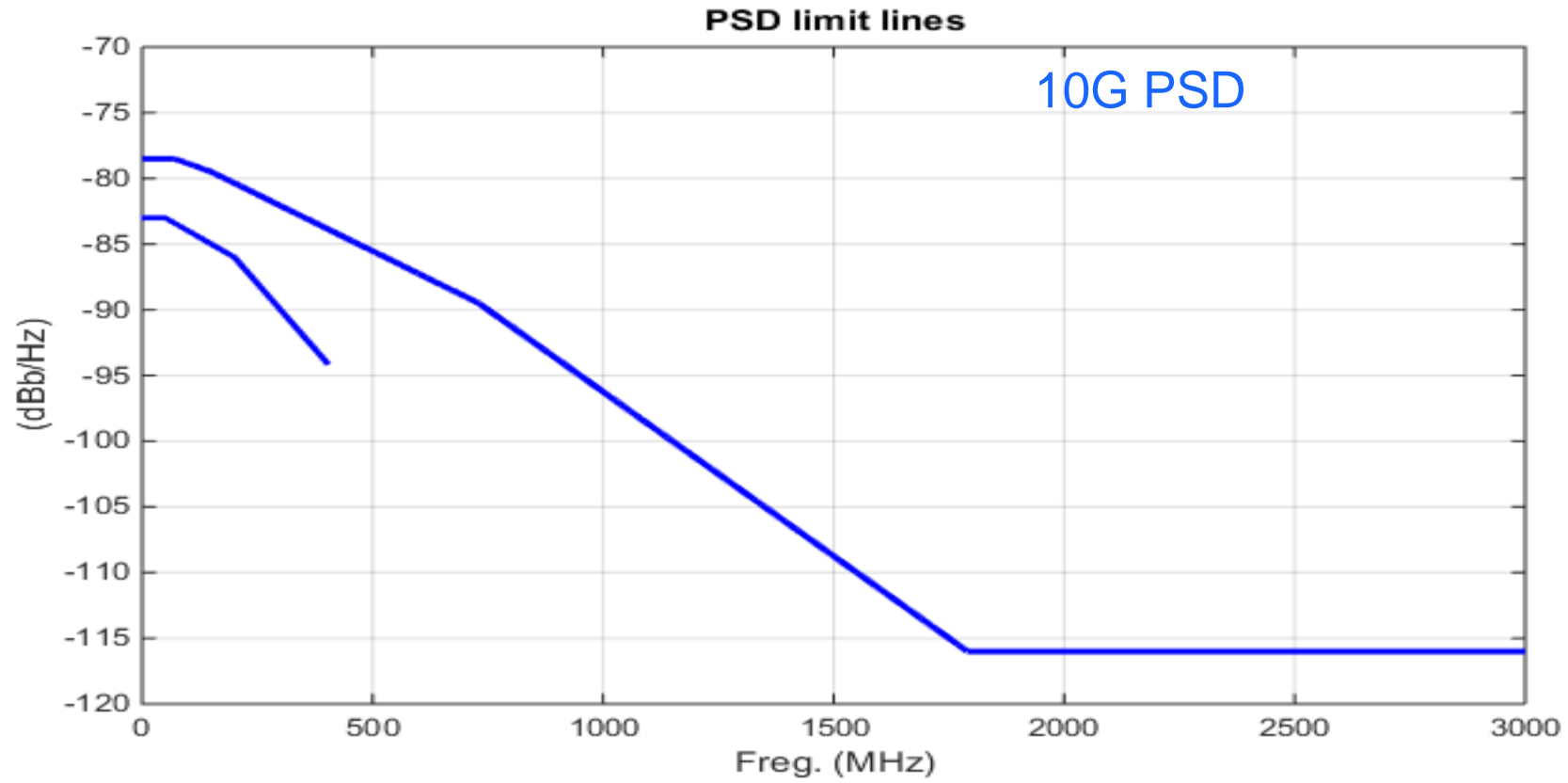
Figure xx-2--2.5/5GBASE-T topology

FREQUENCY-SCALED 10GBASE-T FULL DUPLEX TRANSMISSION

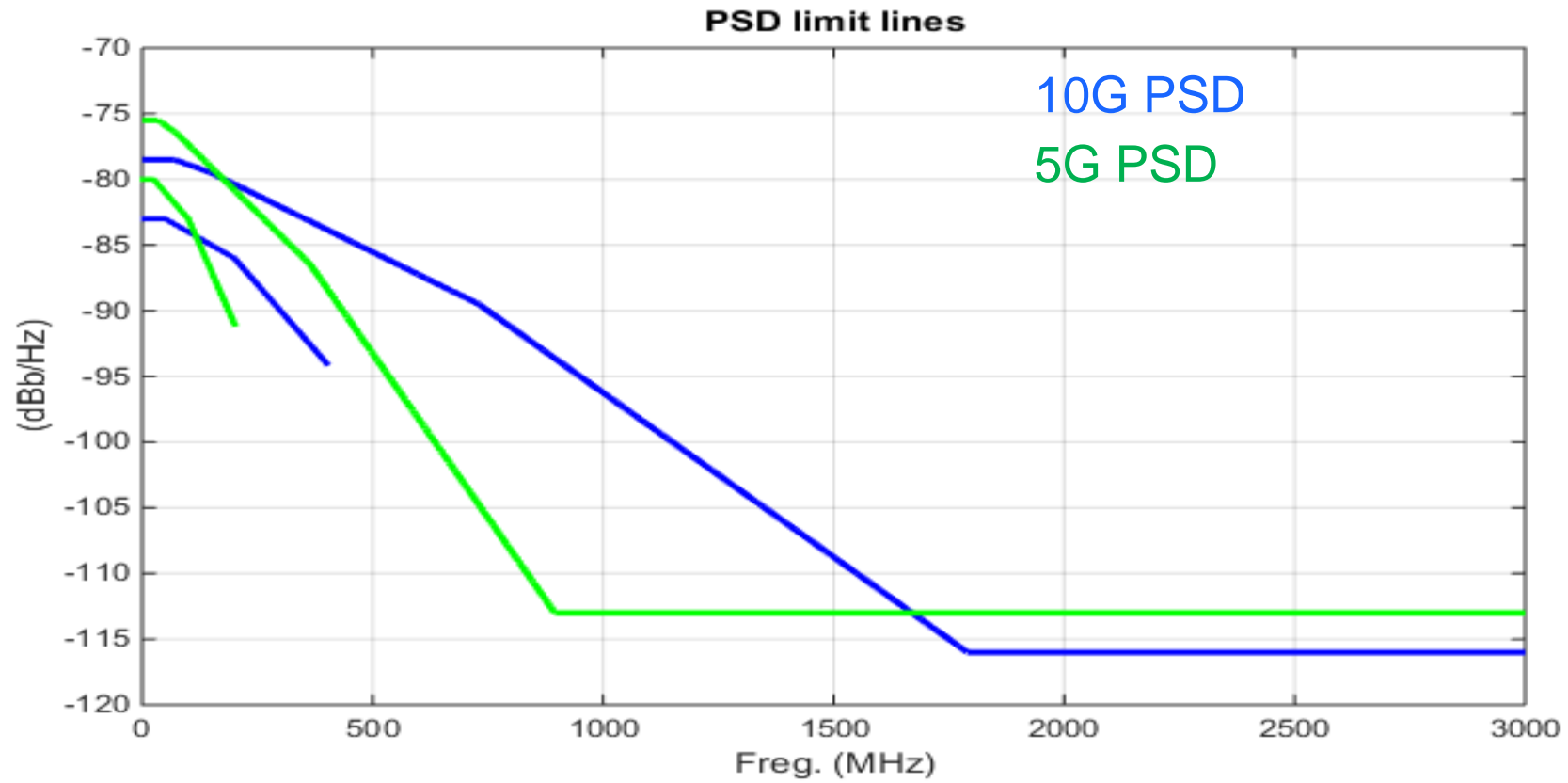


- **Scale frequencies:**
 - $\frac{1}{2}$ for 5G
 - $\frac{1}{4}$ for 2.5G
- **Use industry-wide 10GBASE-T compatible start-up sequence.**
- **Preserve industry accepted implementation delay.**
- **Reuse TX specifications with 3dB (5G) and 6dB (2.5G) higher TX-PSD:**
 - Additional protection against cross-talk
 - Maintains EMC characteristics

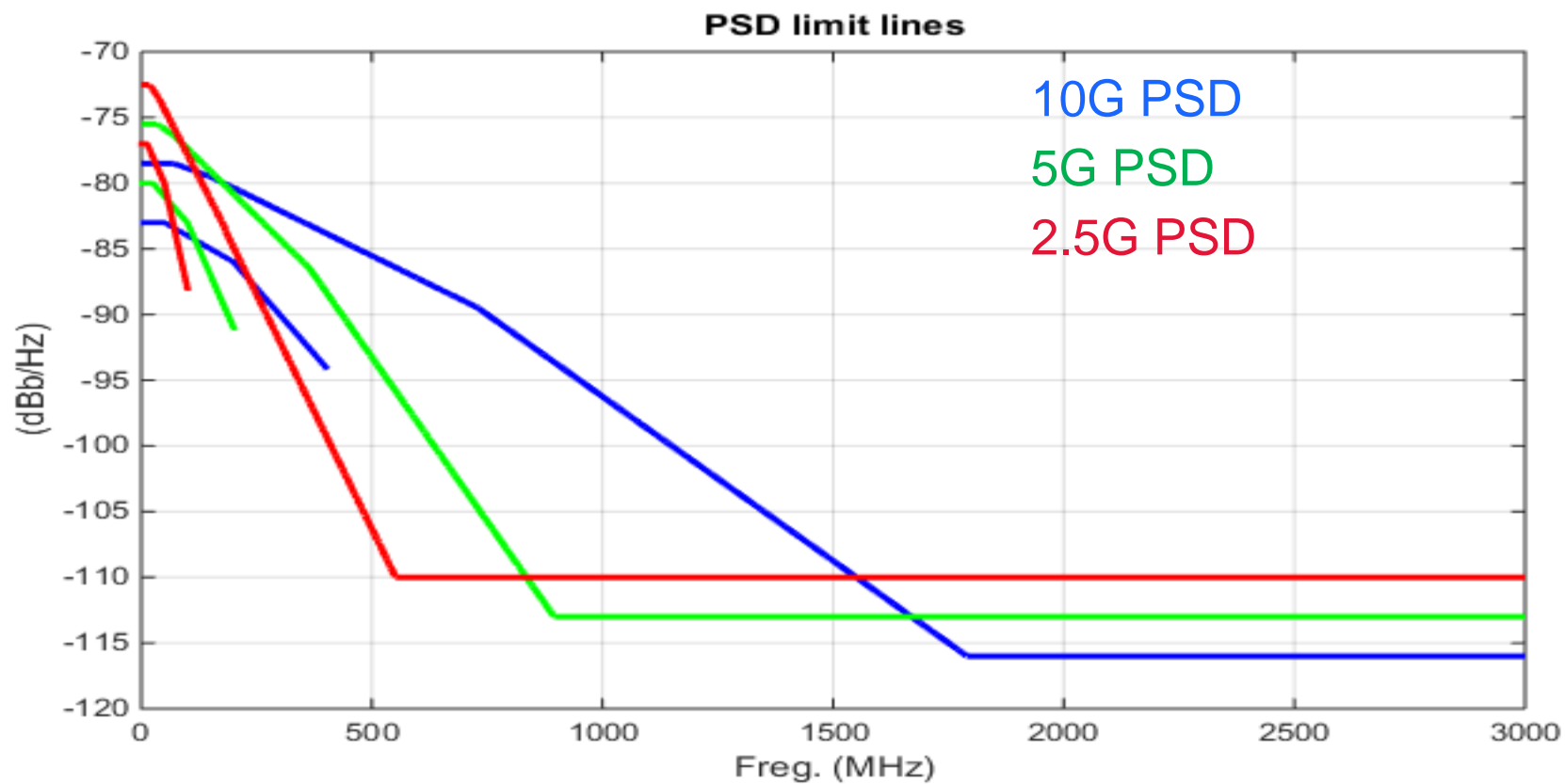
10GB/S TX PSD LIMIT LINES



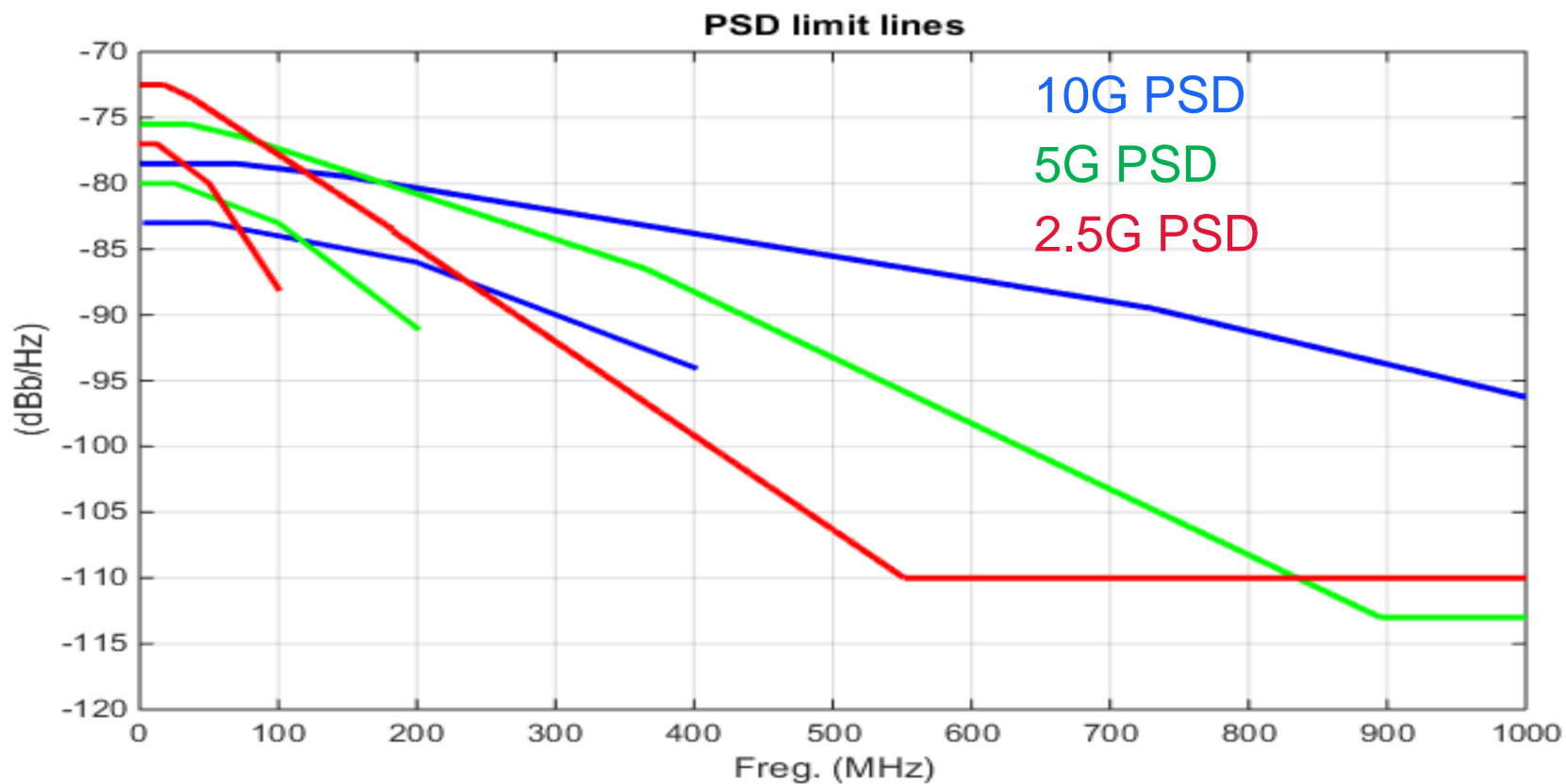
10G AND 5G TX PSD LIMIT LINES



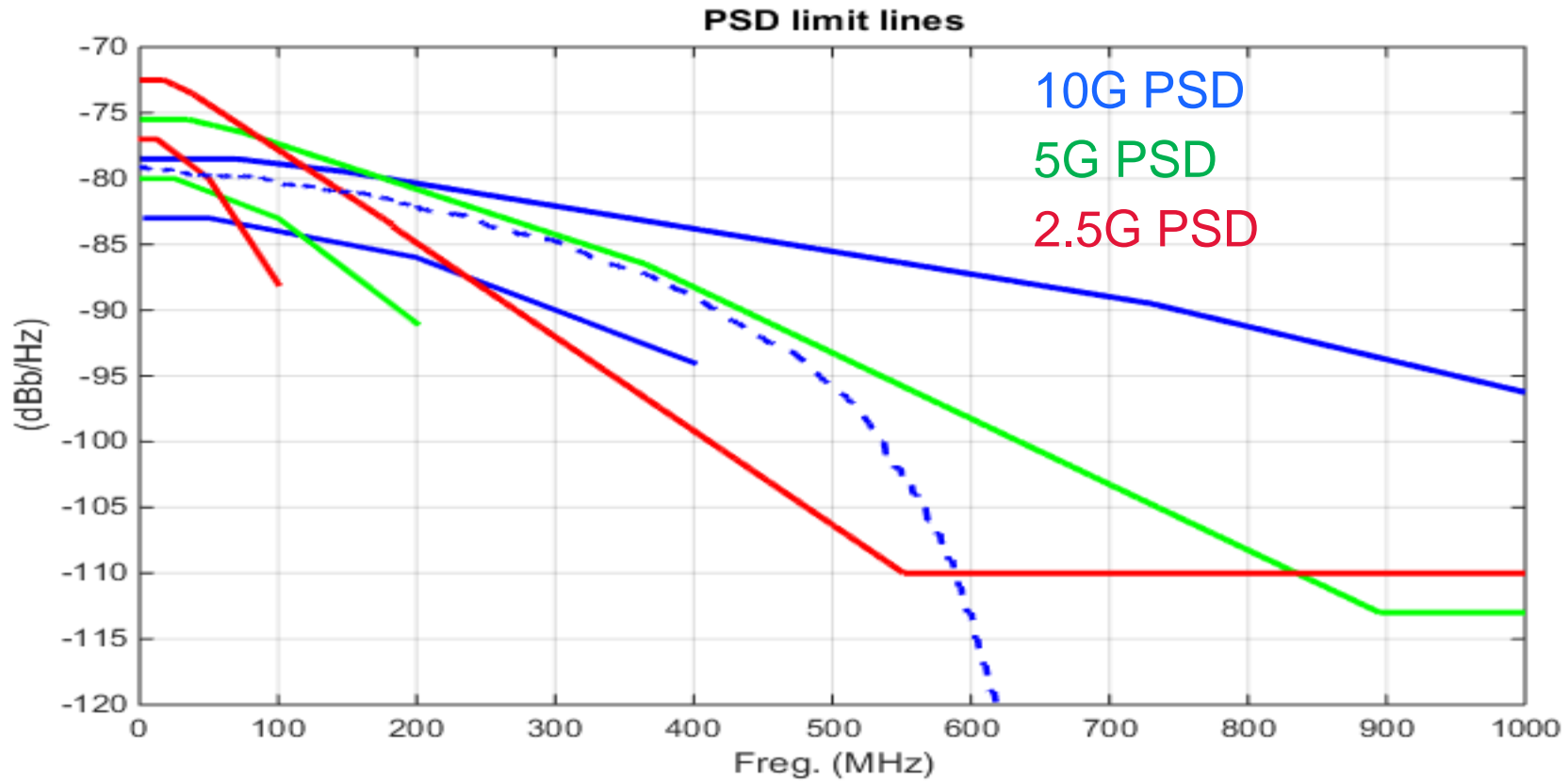
10G, 5G AND 2.5G TX PSD LIMIT LINES



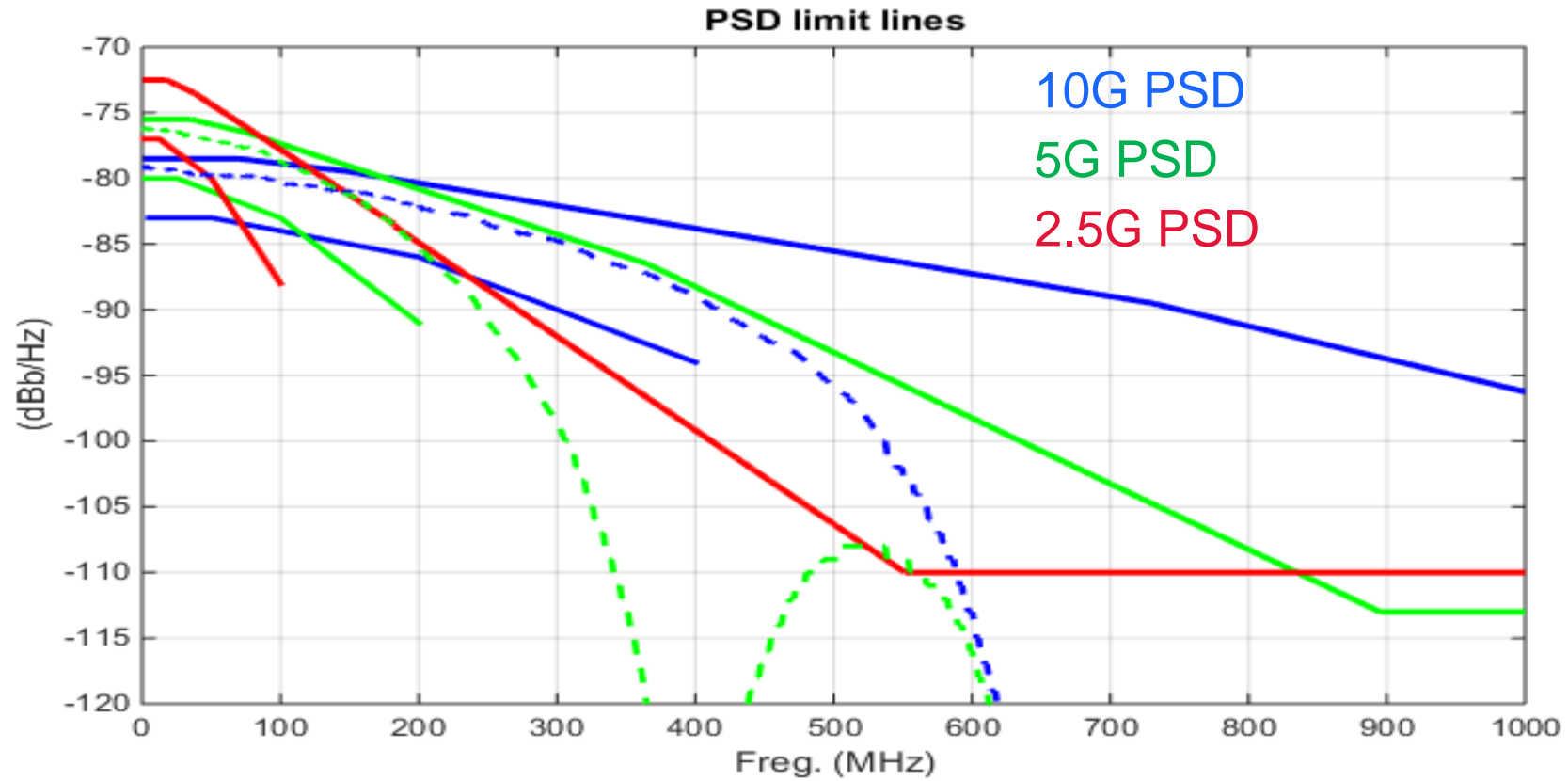
LIMIT LINES FREQUENCY LIMITED TO 1GHZ



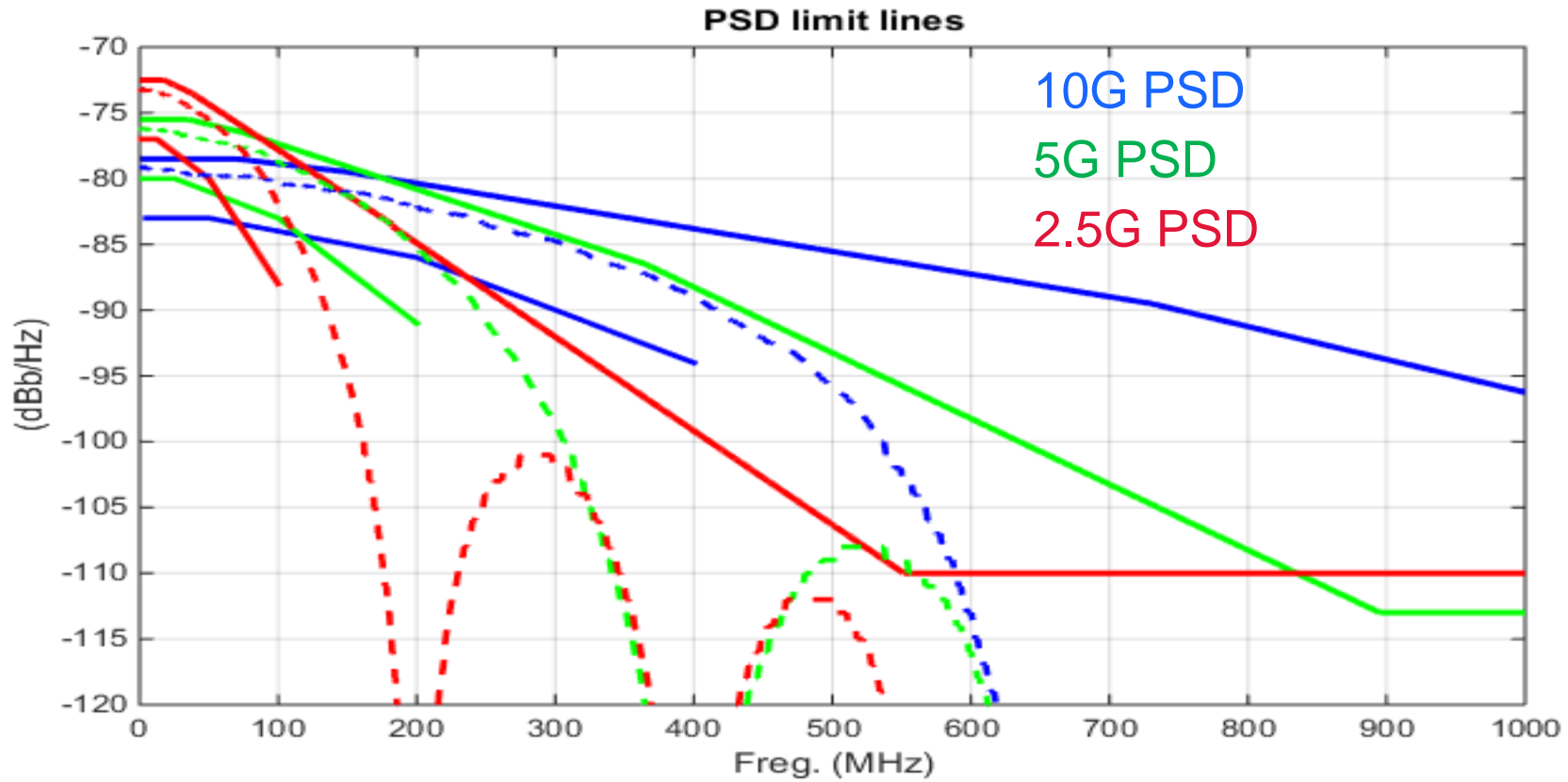
MEASURED 10GB/S TX PSD



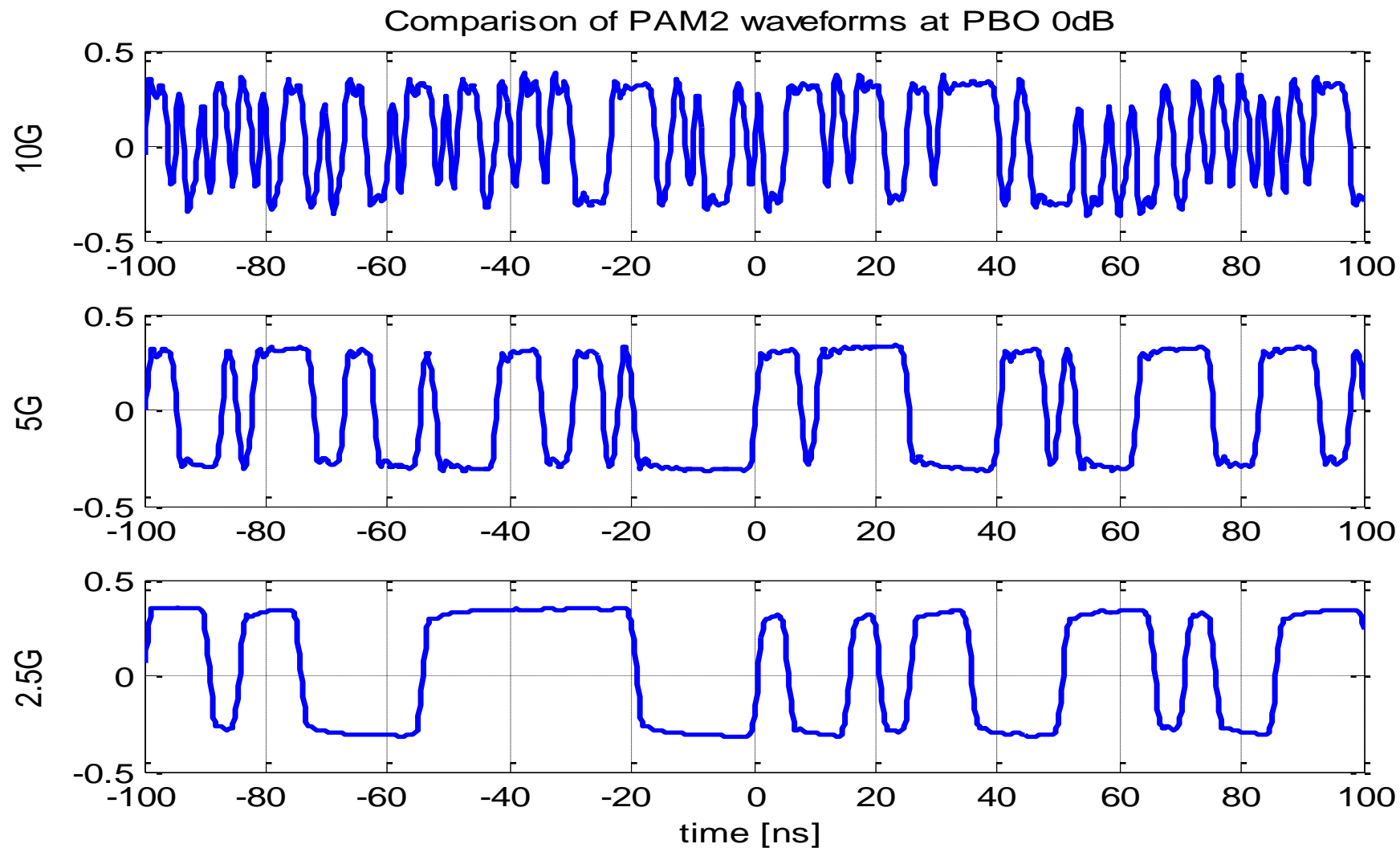
MEASURED 10G AND 5G TX PSD



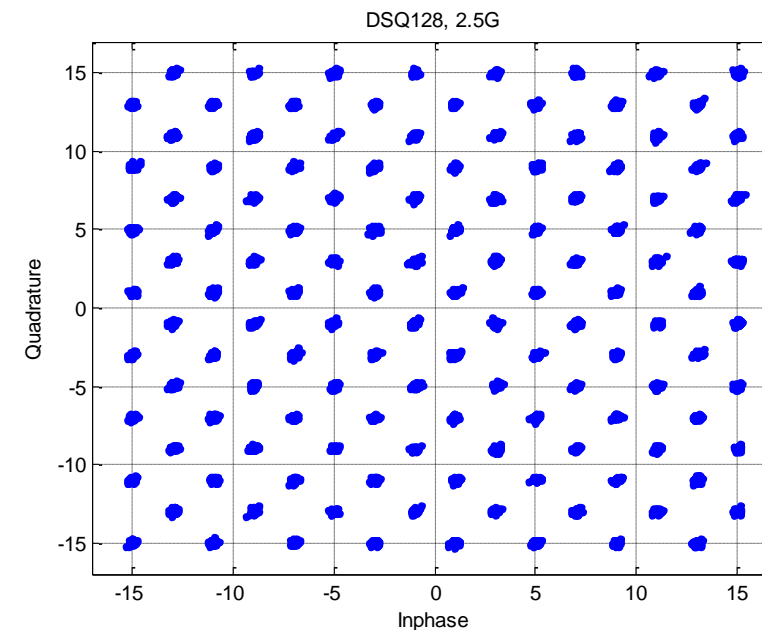
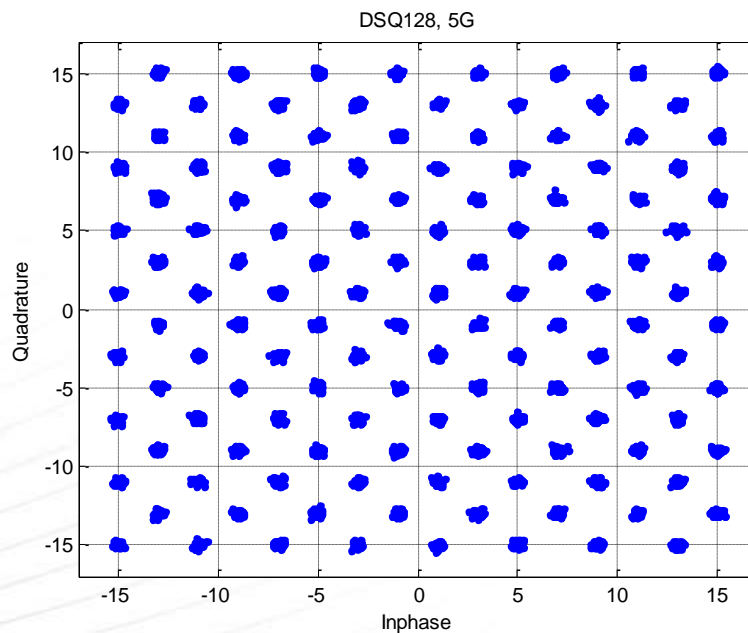
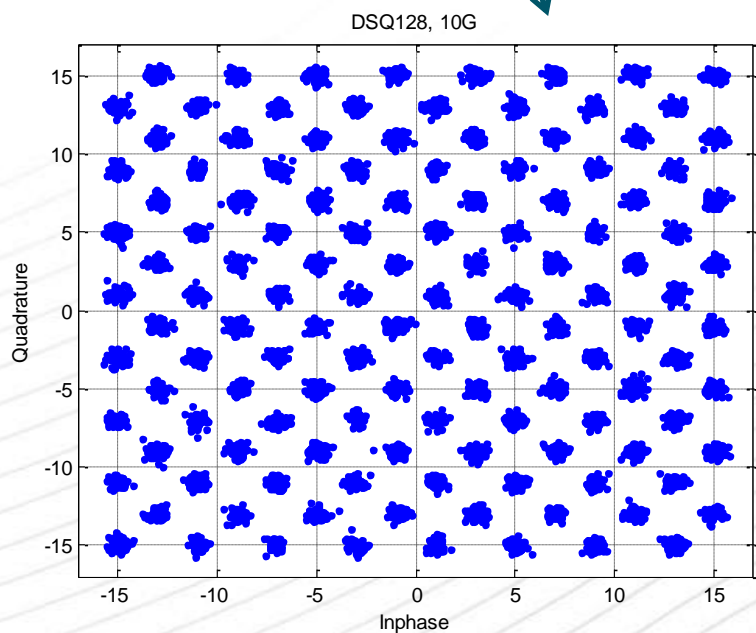
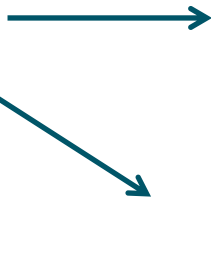
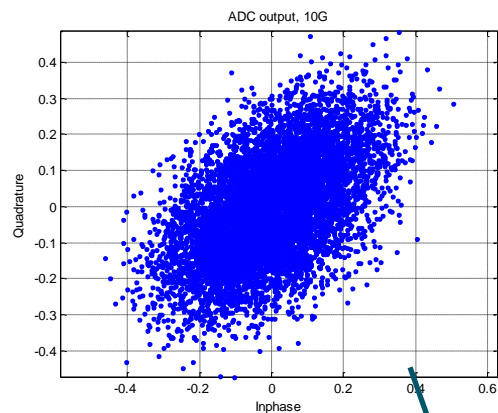
MEASURED 10G, 5G AND 2.5G TX PSD



0DB PBO PAM2 TIME-DOMAIN TX WAVEFORMS



EQUALIZED RX CONSTELLATION



- Echo and NEXT cancellation
- FEXT cancellation and equalization

- **DSQ-128 signaling on four twisted pairs.**
 - 3.125bits per symbol needed for
 - 200MBd for 2.5G
 - 400MBd for 5G
 - 3.5bits per symbol
 - Guarantees sufficient SNR for the timing loop by avoiding false decisions
 - Efficient 12dB constellation partitioning
- **Near Shannon capacity (2048/1723) LDPC code**
- **For 10GBASE-T, this approach was extensively analyzed in the 802.3 standards committee and found to provide the best performance, compared to all other alternative proposals.**
- **All bits are protected**
 - Some bits protected by LDPC code
 - Remaining bits protected by Euclidean Distance

- **Leverage proven 10GBASE-T Technology**
 - Robust DSQ-128 Modulation
 - High-performance LDPC coding
- **Provide excellent performance**
 - Error-free operation over 100m of Cat5e & Cat6 at 2.5Gb/s & 5Gb/s
 - Robust against alien noise sources (24/7 problem)
 - Robust against external noise sources (infrequent)
- **Straightforward implementation**
 - Re-use of 10GBASE-T blocks accelerates multi-vendor implementation
 - Minimal hardware changes
- **Support fast-track standardization**
 - Leverage successful 10GBASE-T standardization
 - Enable direct path to IEEE standardization

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THANK YOU