2.5/5GBASE-T Feasibility

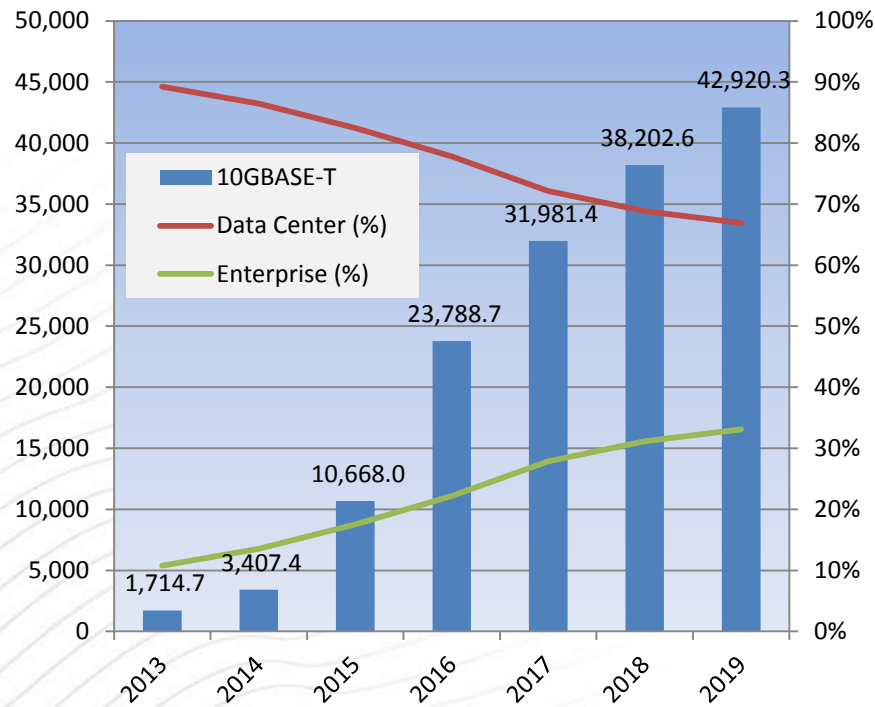**Tom Souvignier**
German Feyh

February 24th, 2015

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

10GBase-T Forecast ('000 Ports)

Legend:
- 10GBASE-T
- Data Center (%)
- Enterprise (%)

Bar values:
- 2013: 1,714.7
- 2014: 3,407.4
- 2015: 10,668.0
- 2016: 23,788.7
- 2017: 31,981.4
- 2018: 38,202.6
- 2019: 42,920.3

Source: Dell'Oro Feb'15

10GBASE-T Standard

- 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

- Extending the 10GBASE-T standard is the fastest and safest path to the next generation 2.5G / 5G standard.
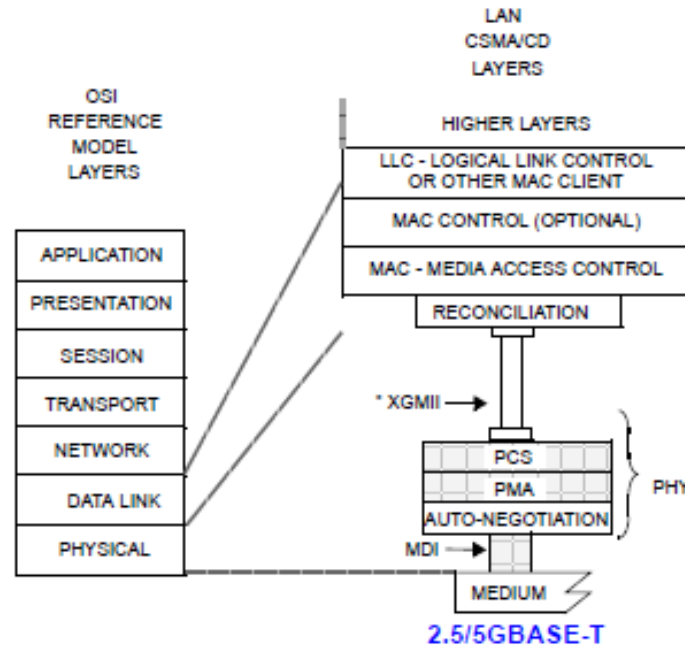
10GBASE-T Modulation and Coding

- DSQ-128 and (2048,1723) LDPC
  - 10GBASE-T is a performance optimized transmission standard less than 2.5dB from Shannon capacity
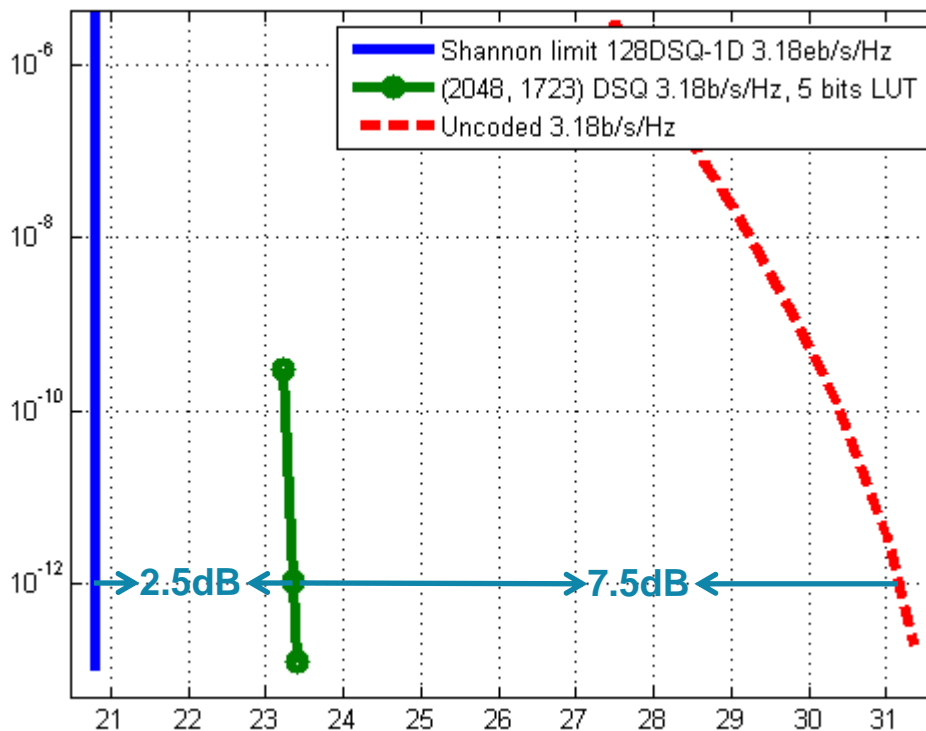
Figure xx-1--Type 2.5/5GBASE-T PHY relationship to the ISO Open Systems Inter-connection (OSI) reference model and the IEEE 802.3 CSMA/CD LAN model
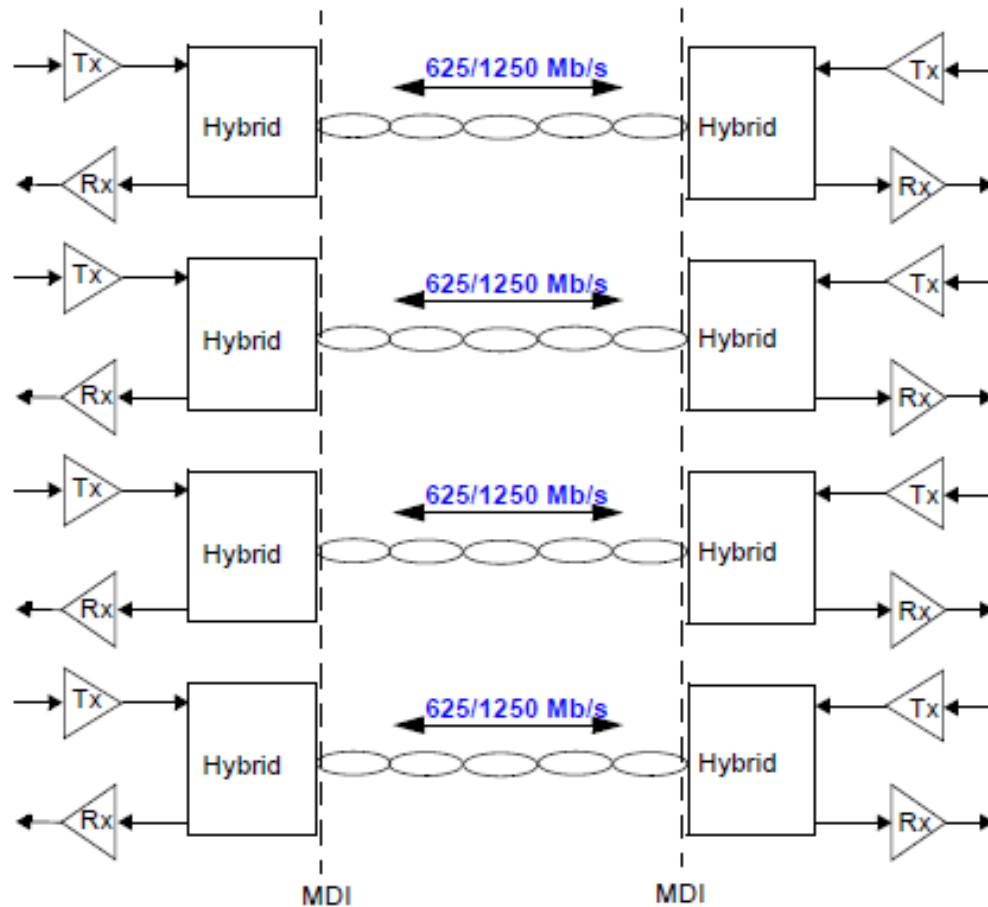
Figure xx-2--2.5/5GBASE-T topology

2.5/5GBASE-T Technical Approach

- Scale frequencies:
  - ½ for 5G
  - ¼ 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

- 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 over competing proposals
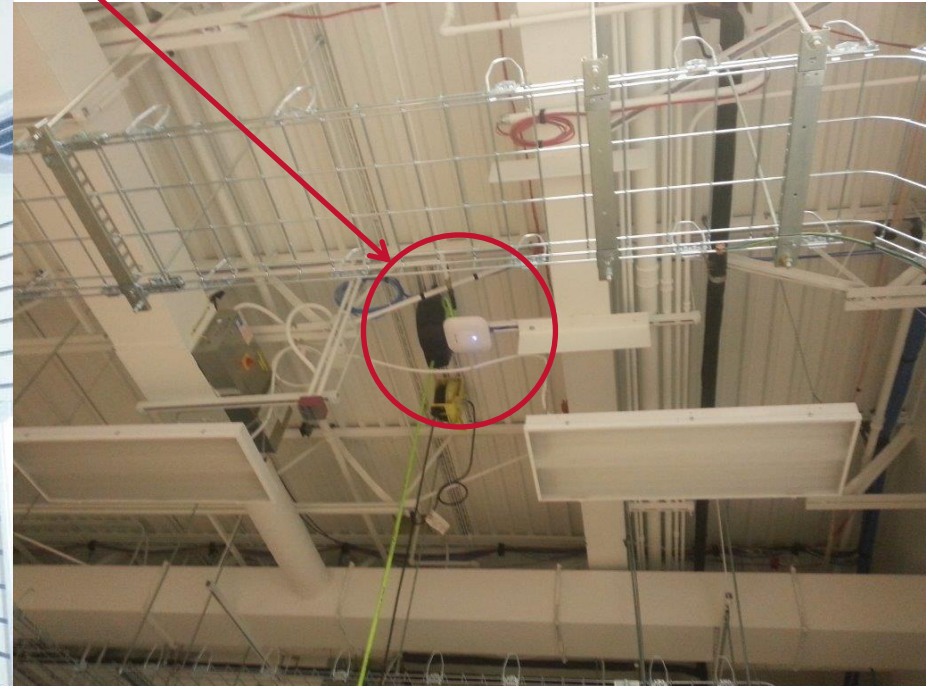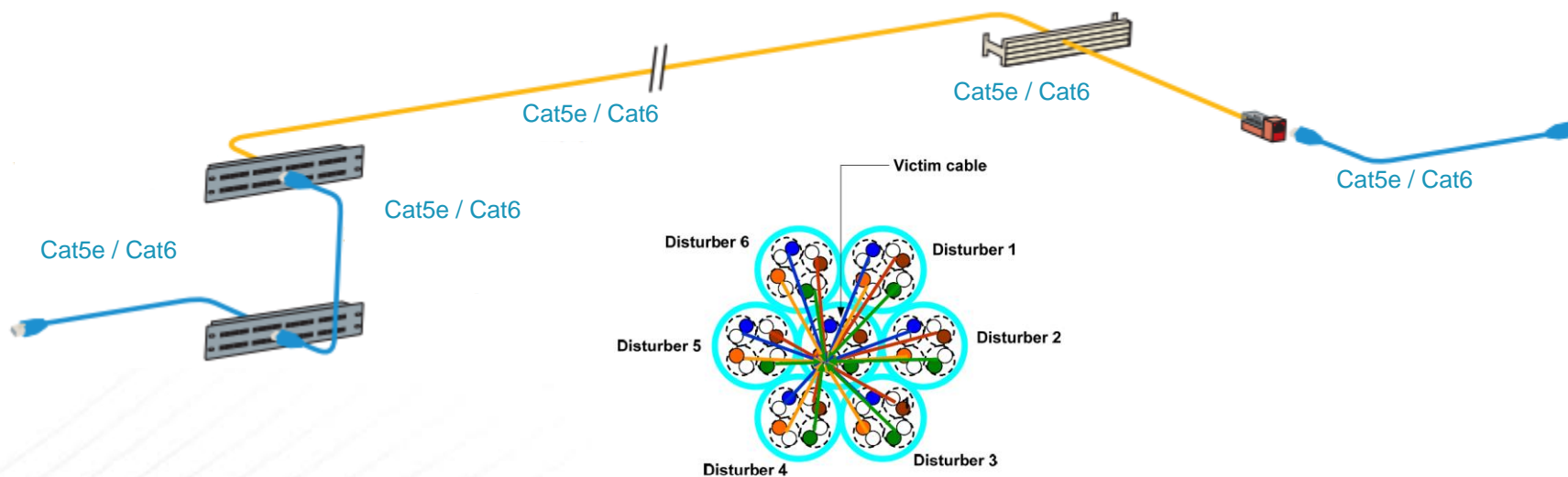
From C. DiMinico: NGEABT Use Case Ad Hoc

Error-free Test Results

Cat5e / Cat6 Channel

Cat5e / Cat6

Cat5e / Cat6

Cat5e / Cat6

Cat5e / Cat6

Cat5e / Cat6

Victim cable

Disturber 6 · Disturber 1 · Disturber 5 · Disturber 2 · Disturber 4 · Disturber 3

Rate	Cable type	Configuration	Aggressor rate	Aggressors length (m)	Victim length (m)
2.5G	Cat5e	6-a-1 (4 segments)	2.5G	100	≥100
5G	Cat5e	6-a-1 (4 segments)	1G	100	≥100
5G	Cat6	6-a-1 (4 segments)	5G	100	≥100

2.5/5GBASE-T Summary

- Leverages proven 10GBASE-T Technology
  - Robust DSQ-128 Modulation
  - High-performance LDPC coding

- Provides excellent performance
  - Error-free over 100m of Cat5e & Cat6 at 2.5Gb/s & 5Gb/s
  - Robust against alien and impulsive noise sources

- Straightforward implementation
  - Re-use of 10GBASE-T blocks accelerates multi-vendor implementation
  - Minimal hardware changes

- Supports fast-track standardization
  - Leverages successful 10GBASE-T standardization
  - Enables direct path to IEEE standardization