200GAUI-1, 400GAUI-2, 800GAUI-4, 1.6TAUI-8 C2M Interfaces: Link Training or Not?

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Kent Lusted, Intel Corporation

v2a

Contributors

- David Ofelt, Juniper
- Howard Heck, Intel
- Adee Ran, Cisco
- Adam Healey, Broadcom
- Jeff Slavick, Broadcom
- Matt Brown, Huawei
- Ali Ghiasi, Ghiasi Quantum / Marvell
- Luz Osorio, Ciena

Preface

- Much work has been done or is in progress on the AUI C2M interfaces. Thank you!
  - https://www.ieee802.org/3/dj/public/23_01/23_0116/lit_3dj_01a_230116.pdf
  - https://www.ieee802.org/3/dj/public/23_01/23_0116/lit_3dj_02a_230116.pdf
  - https://www.ieee802.org/3/dj/public/23_01/23_0116/ghiasi_3dj_02a_230116.pdf
  - There are other contributions not listed here

- Many of these contributions make assumptions about the optimization of the AUI C2M link performance…
  - "link training" or "die-die evaluation"

- Not debating the different *communication path* approaches (e.g. out-of-band vs. in-band) at this time

What is "Link Training"?

- "Link Training" is an ambiguous term, within the scope of the IEEE Std. 802.3 for high-speed serial PHY types
  - The term is used in the standard for BASE-T PHY types (29 instances)
- "Link Training" or "LT" is *loosely* used to refer to the PMD Control Function in Cl 72.6.10, Cl 92.7.12, Cl 136.8.11, and Cl 163.8.11
  - Per Cl 163.8.11, "The PMD control function performs the PMD startup protocol. This protocol facilitates timing recovery and equalization while providing a mechanism through which the receiver can configure the transmitter to optimize performance. The protocol supports these functions through the continuous exchange of fixed-length training frames."

PMD Control Function Usage

- The PMD control function is currently specified for use with most of the backplane and passive copper cable PHYs (e.g., 50GBASE-CR, 800GBASE-KR8, etc.)
  - P802.3dj could follow the same approach for these types of PHYs
- Some AUI C2C (e.g. Annex 120D, Annex 120F, etc.) provide a method to configure by management a transmit equalizer using a set of control and status variables based on the PMD Control Function
  - No training frames are used
  - P802.3dj could follow the same approach for these types of electrical interfaces
- Not used (to date) in IEEE on AUI C2M

Clarity Needed

- The topic of "link training" on the AUI C2M interfaces is surfacing in contributions, Q&A, discussions, and baseline proposals
  - For example, https://www.ieee802.org/3/dj/public/23_01/23_0116/ghiasi_3dj_01_230116.pdf
  - https://www.ieee802.org/3/dj/public/23_01/23_0116/lit_3dj_01a_230116.pdf
  - https://www.ieee802.org/3/dj/public/23_01/23_0116/lit_3dj_02a_230116.pdf
- Assumptions and details on "link training" for AUI C2M are unclear
 - E.g. Out-of-band, in-band, startup, periodic, on-demand, tuning, training, etc.

What are the assumptions for "link training" on the AUI C2M?

Proposed Terms to Reference

- Link Training (LT) = a mechanism through which the receiver can request to adjust the partner's transmitter to optimize performance

- PMD Control Function = a PMD based start up protocol for link training through the continuous exchange of fixed-length training frames (e.g., Cl 136.8.11)

- AUI Control Function = an AUI based protocol for link training

- Module output mode = a method to configure the module output characteristics at TP4 for a particular host electrical interface (e.g. AUI-S and AUI-L in Annex 120G.3.2.1)

- Out-of-service = before MAC link established (e.g., during start up or initialization)

- In-service = after MAC link established (e.g., during normal/mission data or specific retrain event)

- In-band = using the same physical wires as the packet transmission/reception (e.g. the data signal pairs)

- Out-of-band = using different physical wires from the packet transmission/reception (e.g. MDIO or Two-Wire-Interface)

Link Training is an Umbrella Term
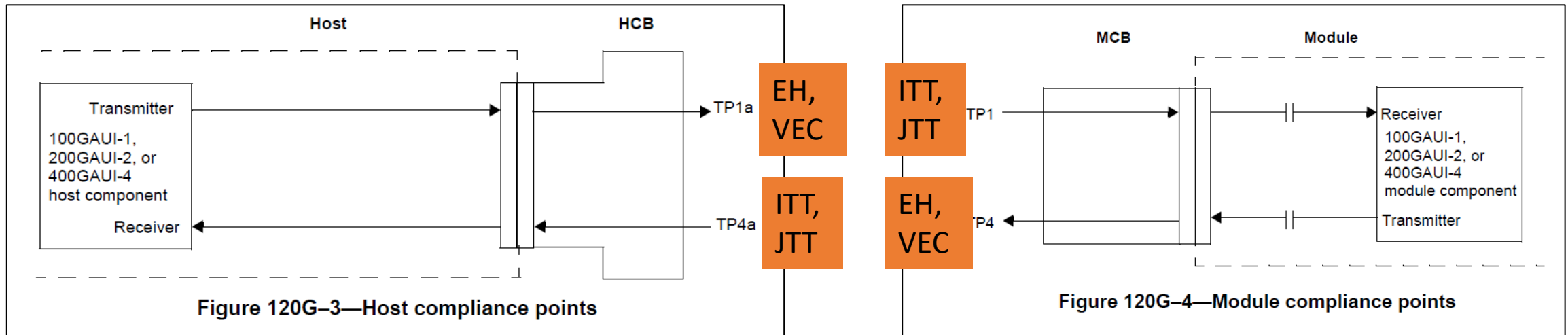
Link Training
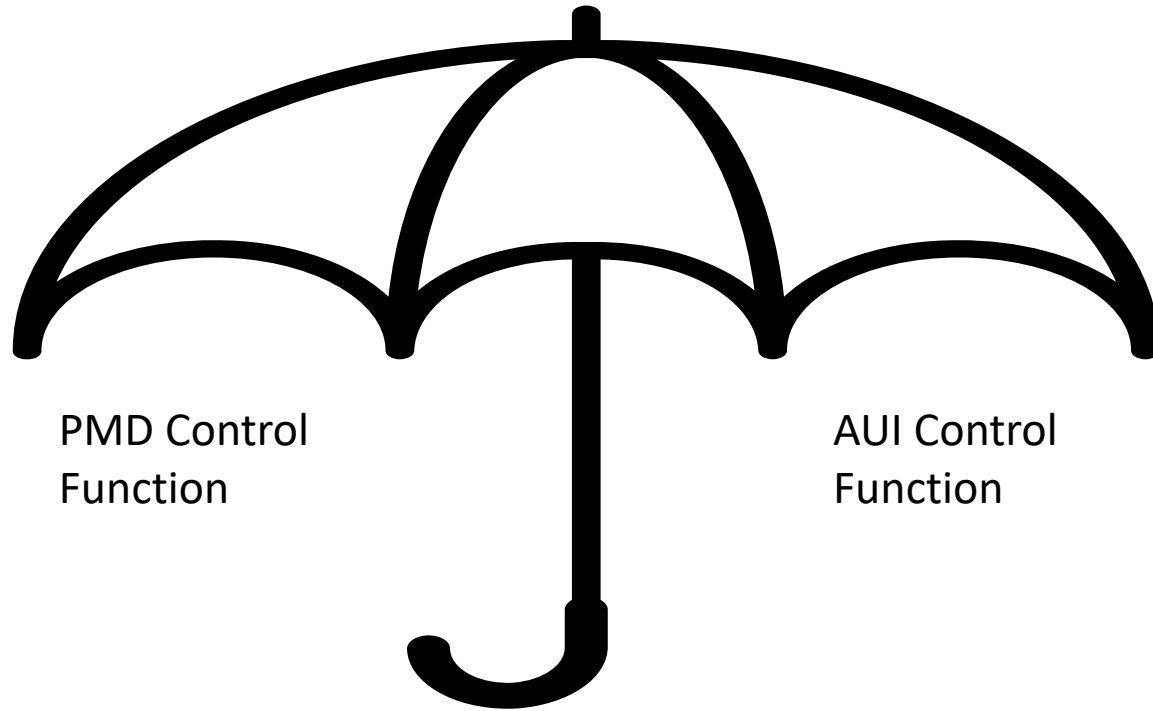
PMD Control
Function

AUI Control
Function

Module output
mode

Potential Impact to AUI C2M Methodology

- From IEEE 802.3ck-2022, the 100 Gbps/lane AUI C2M interfaces use these compliance points and associated methodologies:
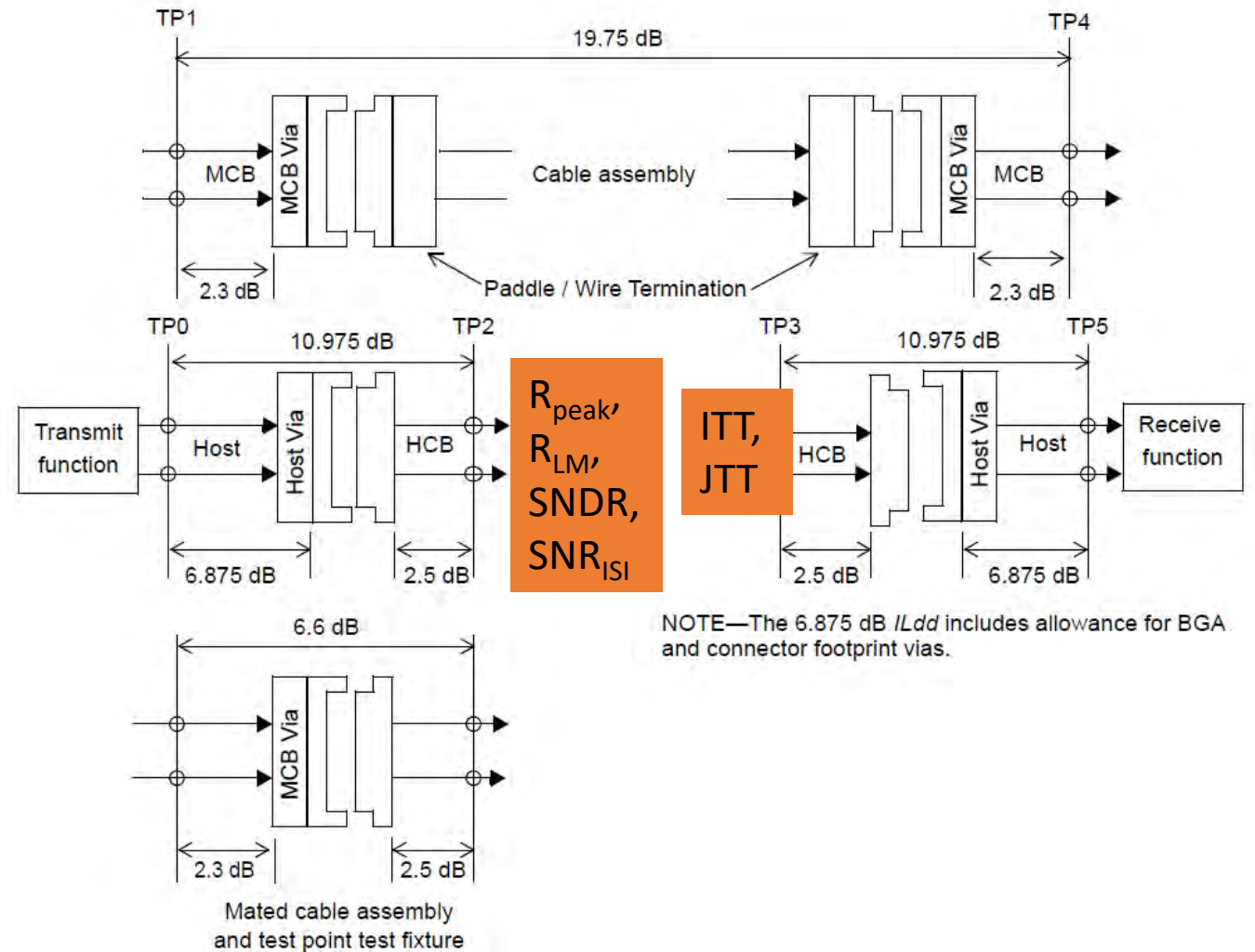

Figure 120G–3—Host compliance points

Figure 120G–4—Module compliance points

- Does this approach still work, if using "link training" on 200 Gbps/lane AUI C2M interfaces?

Note: list of tests is not exhaustive

Comparison

- For reference, passive copper cable test points and associated methodologies from IEEE Std. 802.3ck-2022:

Note: list of tests is not exhaustive

Summary

Attributes to document in the forthcoming AUI C2M baseline proposals:

- First order:
  - Requirement:
    - Use "link training" or not?
    - Mandatory or optional?
  - Test points and methods:
    - Which approach is used?
    - Any modifications?
- Second order:
  - Functional time:
    - Before link establishment ("start up")
    - After link establishment ("normal operation")
  - Operational mode:
    - "out-of-service" or "in-service" or both
  - Communication path:
    - In-band or out-of-band

Thanks!

Potential Straw Poll #1

- I would support the use of "link training" (a mechanism through which the receiver can request to adjust the partner's transmitter to optimize performance) on the 200GAUI-1/400GAUI-2/800GAUI-4/1.6TAUI-8 C2M interfaces
- Y: N: A:

Potential Straw Poll #2

- For 200 Gbps/lane AUI C2M interfaces, I would support a CR/KR-like transmitter and receiver test methodology
- Y: , N: , NMI: , A: