BER Targets for Type 1 and Type 2 PHYs

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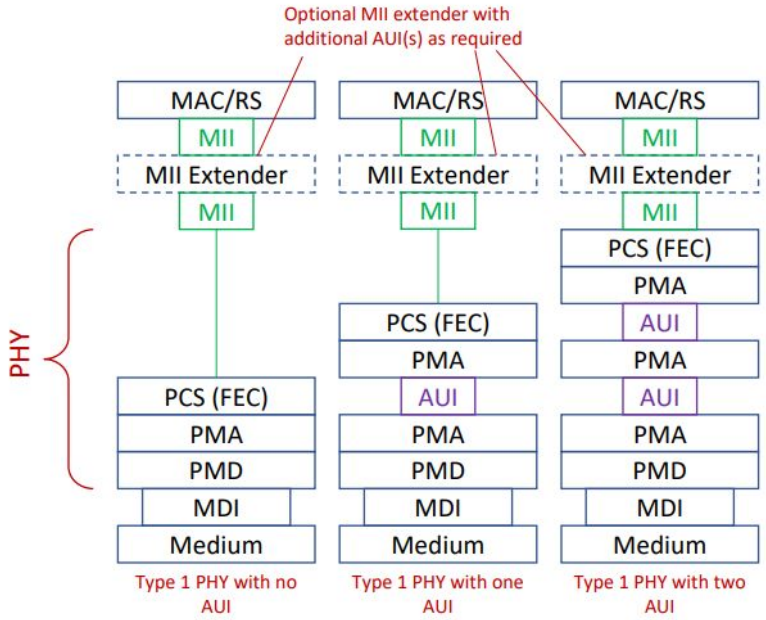
Introduction

- In the past, we primarily defined Type 1 PHYs that allowed the electrical and optical specs to essentially be specified independently
- Now, we have Type 2 PHYs with an inner code FEC for some PMDs
  - And much more challenging channels (electrical and optical) @ 200 Gbps/lane
- The AUI BER nor the PMD BER specs are no longer “isolated” from each other in Type 2 PHYs
  - There are consequences and impacts to serdes design, packaging, system design, optical transceiver design, etc.

Type 1 PHY Reminder

Type 1 PHY/FEC



- A single FEC spans the PHY link (PCS to PCS) which may include up to four AUIs.
- FEC corrects errors that are contributed by the PMD link and the AUIs.
- PMD and Medium characteristics are defined with AUI errors in mind.
- BER trade off between the AUIs and the PMD link.
- More AUIs may be added above the PHY using the optional MII Extender without affecting PHY performance.
- The following PHYs are Type 1 PHY/FEC:
  all 200GBASE-R in 802.3, 802.3ck, 802.3db
  all 400GBASE-R in 802.3, 802.3ck, 802.3db
  all 800GBASE-R in 802.3df

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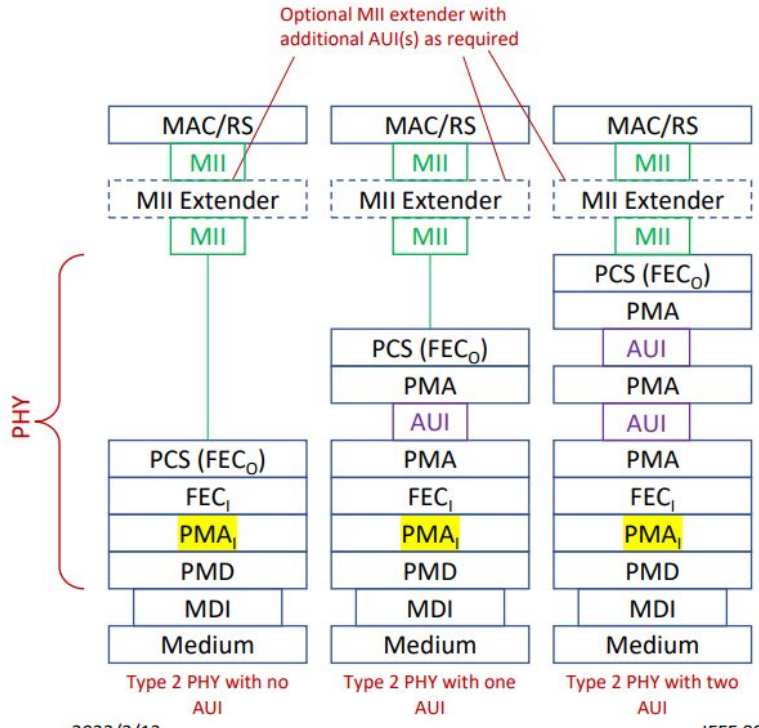
https://www.ieee802.org/3/dj/public/23_03/brown_3dj_01a_2303.pdf

Type 2 PHY Reminder

Type 2 PHY/FEC



- An outer FEC (FEC$_O$) spans the PHY link (PCS to PCS) including up to four optional AUIs (like Type 1)
- An inner FEC (FEC$_I$) spans only the PMD link (PMD to PMD)
- The PMA below FEC$_I$ (PAM$_I$) is different from the PMAs above FECI.
- FEC$_I$ corrects "most" errors contributed by the PMD link
- FEC$_O$ corrects errors not corrected by FEC$_I$ and error contributed by the AUIs
- The combined effect of FEC$_I$ and FEC$_O$ results in the target frame loss ratio (FLR) for the PHY.
- FEC$_I$ and FEC$_O$ defined in conjunction with each other.
- PMD and Medium characteristics defined with AUI errors in mind.
- BER trade off between the AUIs and the PMD link.
- More AUIs may be added above the PHY using the MII Extender without affecting PHY performance.
- This PHY/FEC type is new for 802.3.

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https://www.ieee802.org/3/dj/public/23_03/brown_3dj_01a_2303.pdf

Link Diagram Reference

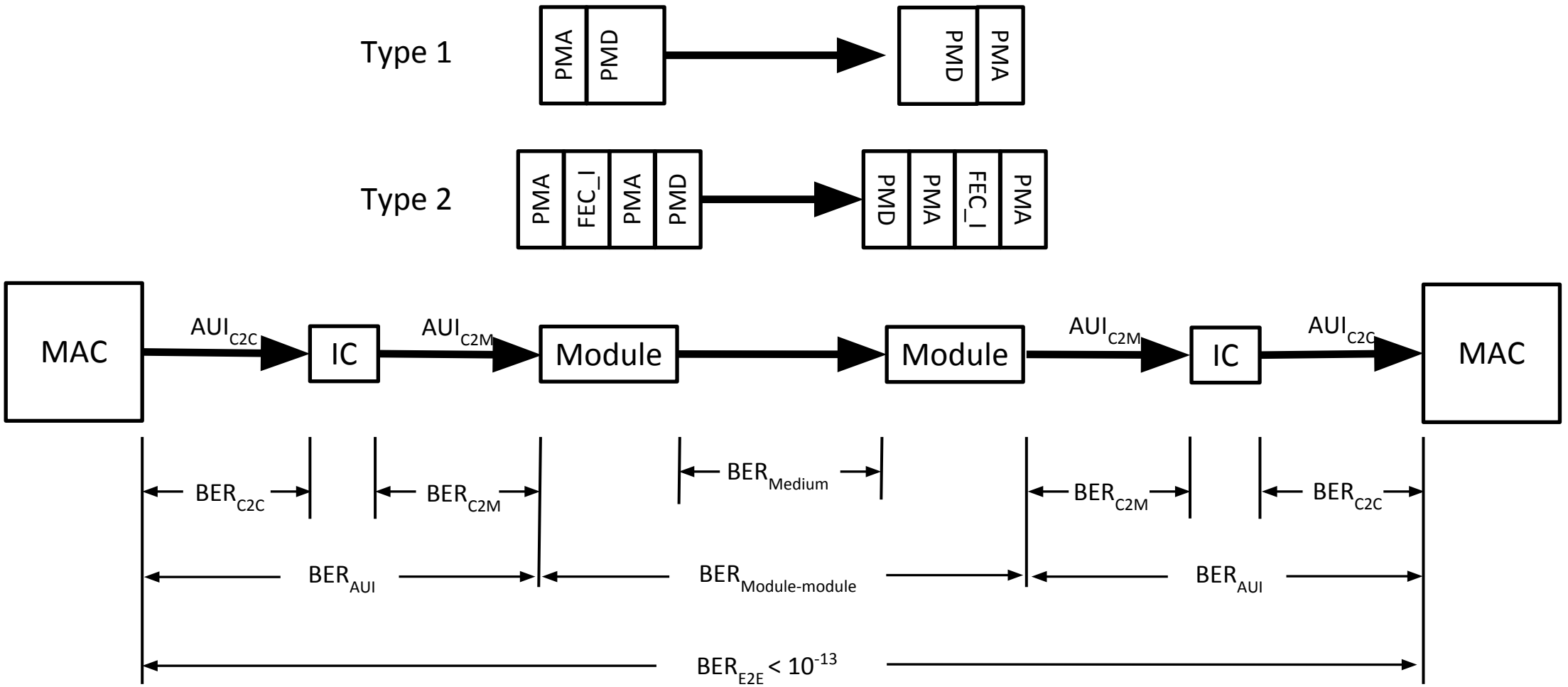

Diagram courtesy of John D'Ambrosia

AUI BER observations and tradeoffs

- The end-to-end BER budget is already fixed and defined by the adopted RS544
- Traditional IEEE 802.3 architecture supports existence of both C2M and C2C per host
    - Even though there is strong product pressure to only implement a single C2M interface
- “AUI BER” target should consider the combination of C2M + C2C and define the leftover BER allocation for optical/module
    - Implementers may use the C2C+C2M budget for a single C2M
    - In 802.3dj, various allocations between C2M and C2C can be considered (such as ran_3dj_01_2305, brown_3dj_elec_01_230420)
- Error propagation is more of a factor at 200 Gbps/lane (Type 2, but also Type 1)
- Interest exists to also support Type 1 (bypass FEC_i proposal) to optimize for latency. Dependent on target AUI BER

AUI BER observations and tradeoffs (2)

- AUI C2M BER is a normative spec
  - Example, Annex 120G.1.1
- Categorization of medium-loss and high-loss AUI C2Ms doesn’t change the single AUI BER target we could adopt
  - More of an implementation consideration

AUI BER observations and tradeoffs (3)

AUI BER targets, total (C2C + C2M)	Pros	Cons
2e-5 (Adee Ran proposal)	• Consistent with 100G AUI BER Target • Consistent with 100G/λ BER allocation • Supports FEC_i bypass	• Early host implementation challenges
2.5e-5 (Lenin Patra proposal)	• Extra design margin for host implementations	• No support for FEC_i bypass • Reduces coding gain available for optics • higher FLR floor • Less tolerance for error propagation
2.4e-4	Assumes host implementations exceed ability for optical module BER allocation to be met, therefore requiring extender in module (FEC encode/Decode)*	

*Note: we may want to define a formal naming for an AUI channel that exceeds the AUI BER target and requires an extender to be implemented in the optics

Summary

The AUI BER and the PMD BER specs are no longer “isolated” from each other in Type 2 PHYs.

- It is more complicated than ever before

“AUI BER” target should consider the combination of C2M + C2C and define the remaining BER allocation for optical/module

An AUI BER target needs to be adopted now by the P802.3dj TF to move us forward

- Optical and electrical baseline proposals are currently blocked!
- We can refine as needed in the future

Straw Poll #n

I would support having a single AUI BER target for all loss categories of C2M AUI inside a Type 1 or Type 2 PHY

- Y: N: A:

Straw Poll #n+1

I would support adopting a AUI BER target of ___ for Type 1 and Type 2 PHYs

A: 2E-5 (Adee Ran proposal)

B: 2.5E-5 (Lenin Patra proposal)

C: NMI