IEEE P802.3dv · NOVEMBER 2026 PLENARY

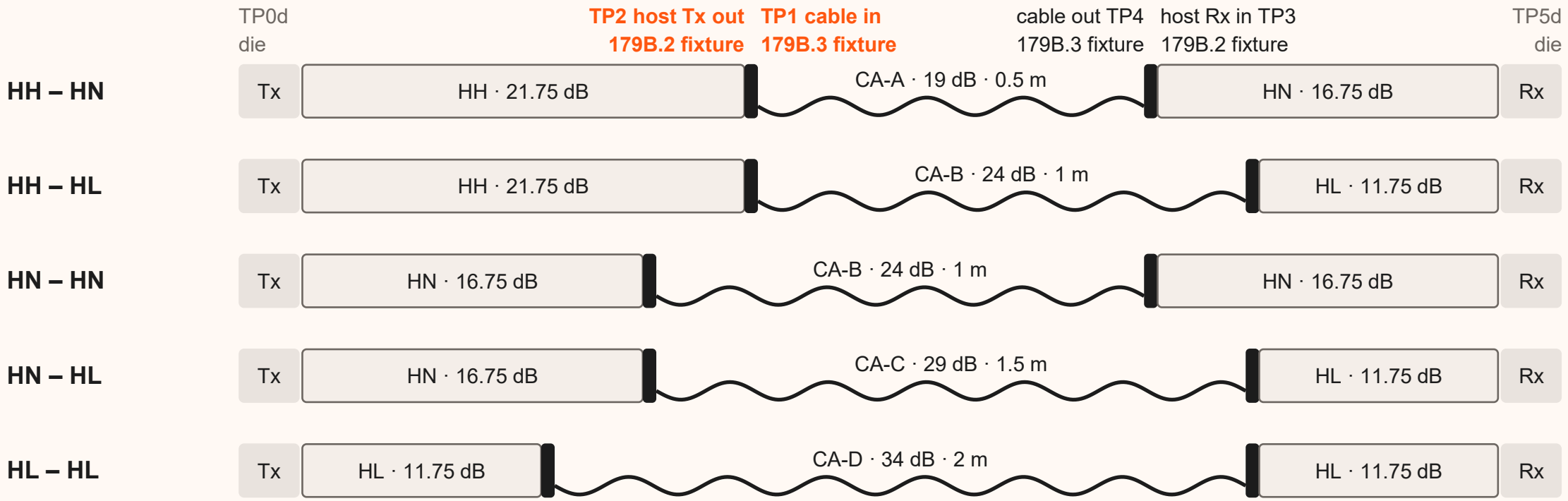
Captive Retimed Cables for 400GPL

Proposal

C2M electrical interfaces with explicit Captive Retimed Cable assembly requirements for error performance, delay, skew, startup and recovery.

Ari Sharon, Terawand

802.3dj CR: cable reach is traded against host loss



Each dB of cable comes out of the host

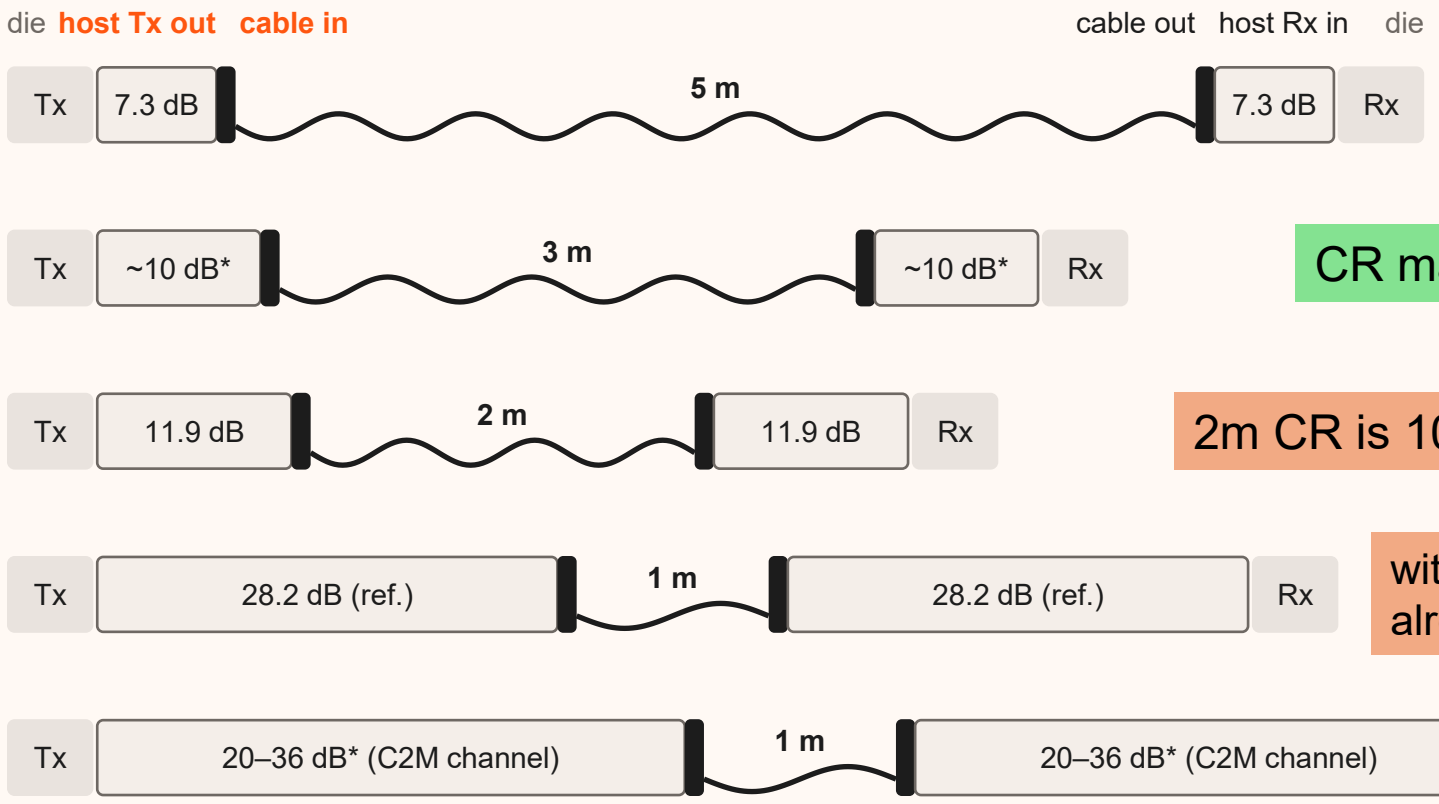
Reference loss allocations at 53.125 GHz

Reference arithmetic: TP0d–TP5d = TP0d–TP2 + TP1–TP4 + TP3–TP5d − 2 × 8.75 dB = 40 dB.

Lengths are the expected reach of each cable class

Copper reach objectives and AUI host loss

Host segments: AUI-C2M reference host loss at Nyquist
cable: CR reach objective

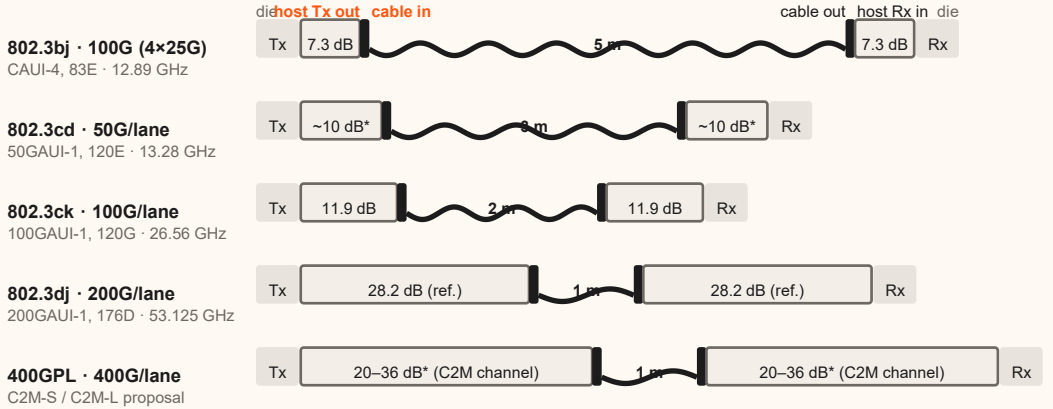


Target CR Reach shrinks faster than the AUI host budget grows

Only a module or Fully Retimed port can use the C2M budget

Fully retimed solutions resolve the trade-off

- **Only a module or Fully Retimed port can use the C2M budget**
- Various **captive** retimed cable solutions are gaining ground in the industry. **none can claim 802.3 compliance as an assembly**
  - **Electrical (AEC)**
  - **AOC**
  - **RF Waveguide**
  - **Optical slow and wide (uLED/uVCSEL)**



- **<u>What they share</u> :**
  - The host sees a retimed AUI-C2M port and never pays for cable length. The medium and its electronics are captive: a closed system that, today, has no full official verification definition.

- **<u>What they lack :</u>**
  - No 802.3 requirement on the assembly as a whole: no error allocation for the internal path, no delay or skew limit through the assembly. Captive optics can borrow Clause 180 PMDs; nothing requires it.

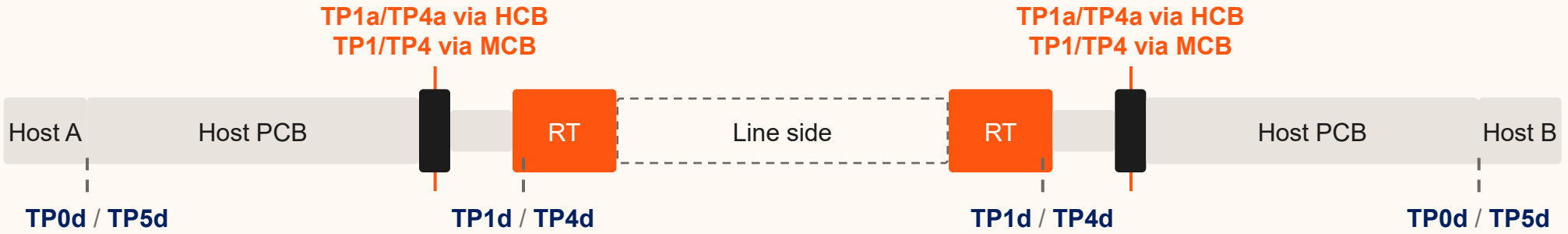
Active cable nomenclature

Name	Cable	Host port sees
DAC Direct attach copper, passive		CR PMD (Clause 179)
ACC Active copper cable, linear		CR-like port; no IEEE cable spec
Half AEC Retimer on Rx-to-host path only		Rx: AUI-like · Tx: CR-like
AEC Active electrical cable, retimed		AUI-C2M (Annex 176D)
AOC Active optical cable		AUI-C2M (Annex 176D)

Scope of this presentation : Captive active cable assemblies with C2M electrical interfaces at both ends, retiming in both transmission directions, and transparency to the host PCS/FEC stream. The internal medium may be electrical, optical or RF.

Terminology: lusted_3df_02a_2207

Captive Retimed Cable architecture and compliance boundaries



Orange: compliance points accessed through HCB/MCB fixtures
blue: die-level reference points

Specified today (176D)

- Module input TP1 / output TP4 (176D–5 / –3)
- Host output TP1a / input TP4a (176D–2 / –4)
- ILT (E1), RTS and adjacent-loss-of-signal handling
- 46.08 ns: component Tx+Rx including channel*

Specific definition needed

- Assembly error allocation and stressed test
- Assembly delay, lane skew and variation
- Internal readiness/fault mapping to C2M

*176D.5: Tx+Rx sum includes the AUI channel in one direction; this is not a one-way retimer limit.

Captive Retimed Cable disguised as DR-What can go wrong?

- **To the host, a DR module and a retimed cable end can look the same**:

  same PCS, same PMA, same C2M interface, no auto-negotiation

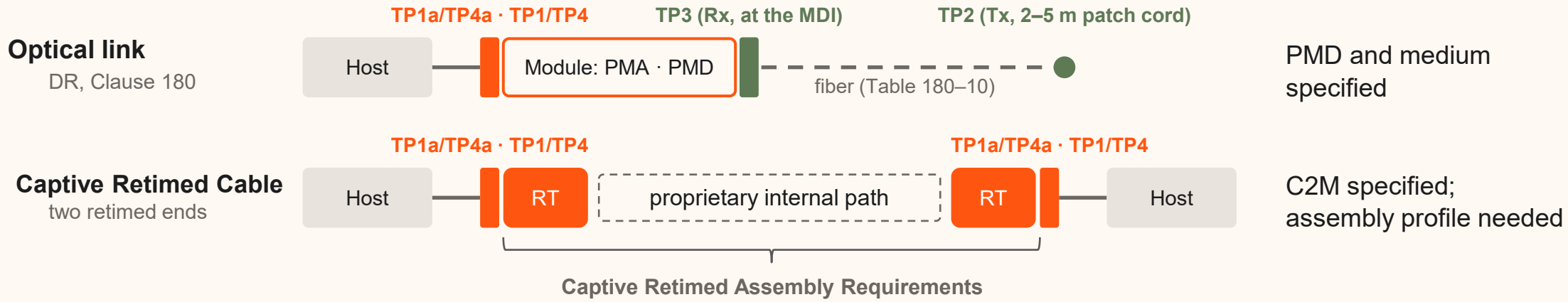
  - What goes wrong is that **nothing makes it behave that way**, and nothing can check it

- **Example** - the DR middle link is allowed 2.28×10^{-4} and is tested for it at

  TP3 with a stressed optical signal and an error mask.

  A cable has no TP3. Its line side can be worse, or burstier, while both ends still pass their C2M tests.

802.3dj D3.2 : DR optical link vs. Captive Retimed Cable

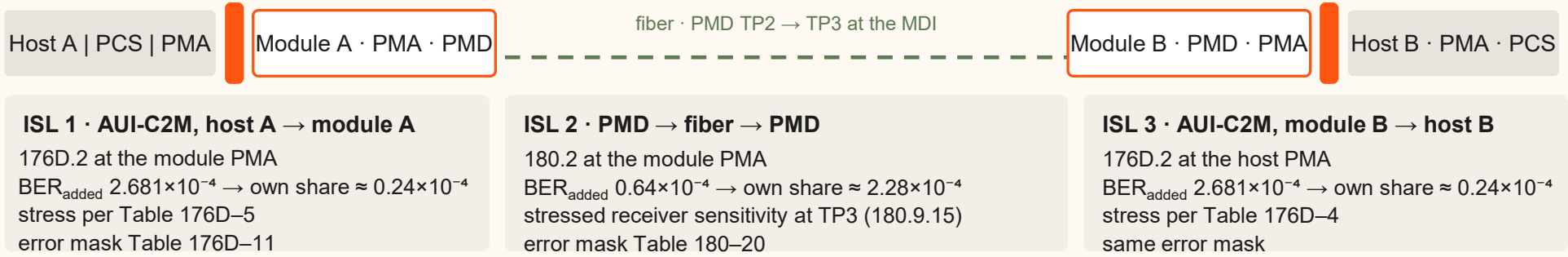


	DR optical link	Captive Retimed Cable
C2M host/module electrical compliance (176D.6)	●	●
C2M receiver error test at adjacent PMA (176D.2)	●	●
C2M component Tx+Rx delay budget (176D.5)	●	●
PCS-to-PCS error expectation (174A.6)	●	●
ILT/RTS and adjacent loss-of-signal handling (178B)	●	●
Error allocation beyond the host C2M interfaces	● 180.2	○
Stressed-test conditions and methods beyond the host C2M interfaces	● 180.9	○
Delay, skew and skew variation beyond C2M	● 180.4	○

DR path tests every link; while captive cable leaves one untested

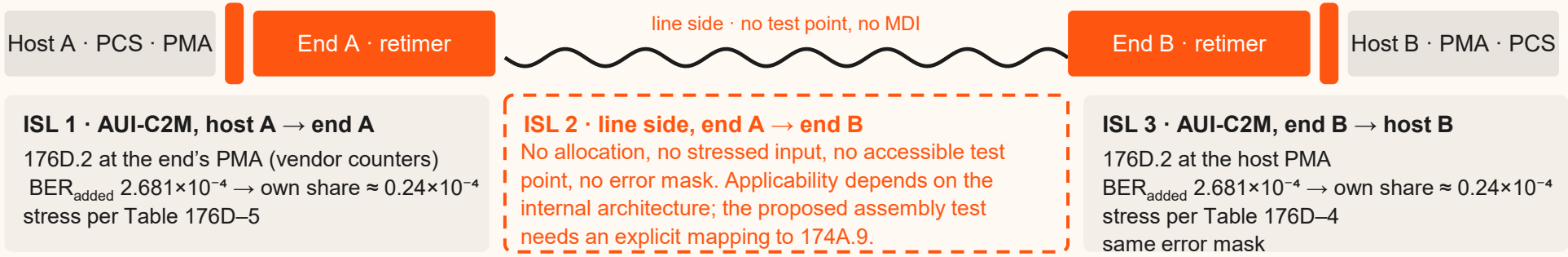
174A.9 tests one inter-sublayer link (ISL) and s the rest at BER_{added}
Component qualification relies on the remaining path meeting the allocation represented by BER_{added}

DR optical link



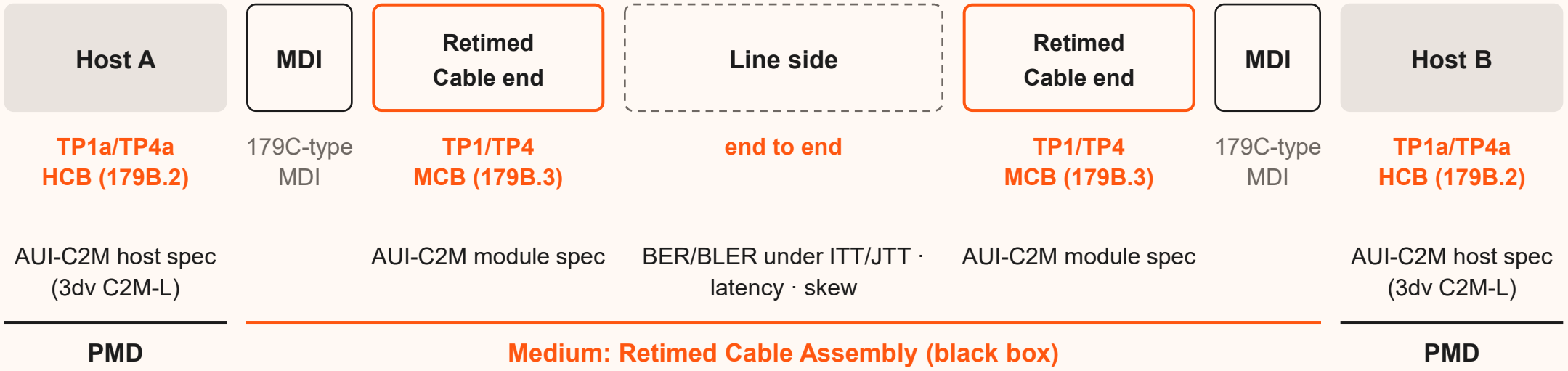
Own shares 0.24 + 2.28 + 0.24 = 2.76×10⁻⁴ ≤ BERtotal 2.921×10⁻⁴ (174A.6): consistent, and every term in the sum is measured by its own test.

Captive Retimed Cable



0.24 + ? + 0.24: the two C2M tests leave 2.28×10^{-4} (Table 174A–1) for the line side, and nothing verifies it.

Proposal: Captive Retimed Cables as a Specified Building Block



- **Hosts: nothing new**
- **Cable ends: an existing module specification-** Each end meets the AUI-C2M module specification at TP1/TP4 through the MCB
- **Assembly: the new part -** The cable is the medium, a black box held to end-to-end requirements: error ratio under stress, latency and lane skew from end-A TP1 to end-B TP4

Proposed end-to-end test

New item	Proposed test	Reuses
Error ratio through the cable	Stress at end-A TP1 (176D–5); measure at end-B TP4 with a defined measurement receiver; all-lanes histogram method (174A.9.7)	174A.9; BERadded = links outside the boundary, set with the allocation
Latency	One-way delay, end-A TP1 → end-B TP4; limit to be set	176D.5 is a Tx + Rx component budget, not reusable as is
Lane-to-lane skew	Skew and variation added between MDIs	Reference from the CR budgets (179.7): 80 ns / 2.8 ns, not yet applicable
Start-up and recovery	Mapping of line-side readiness and faults into SIGNAL_OK, RTS and the 178B states; start-up and recovery pass criteria	Annex 178B
Both directions, all lanes	A→B and B→A, all lanes active; operating corners, lengths, supported modes	Same setup, mirrored