Proposed Copper Cable Objective for 400G per lane

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rev1a

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Supporters and Contributors

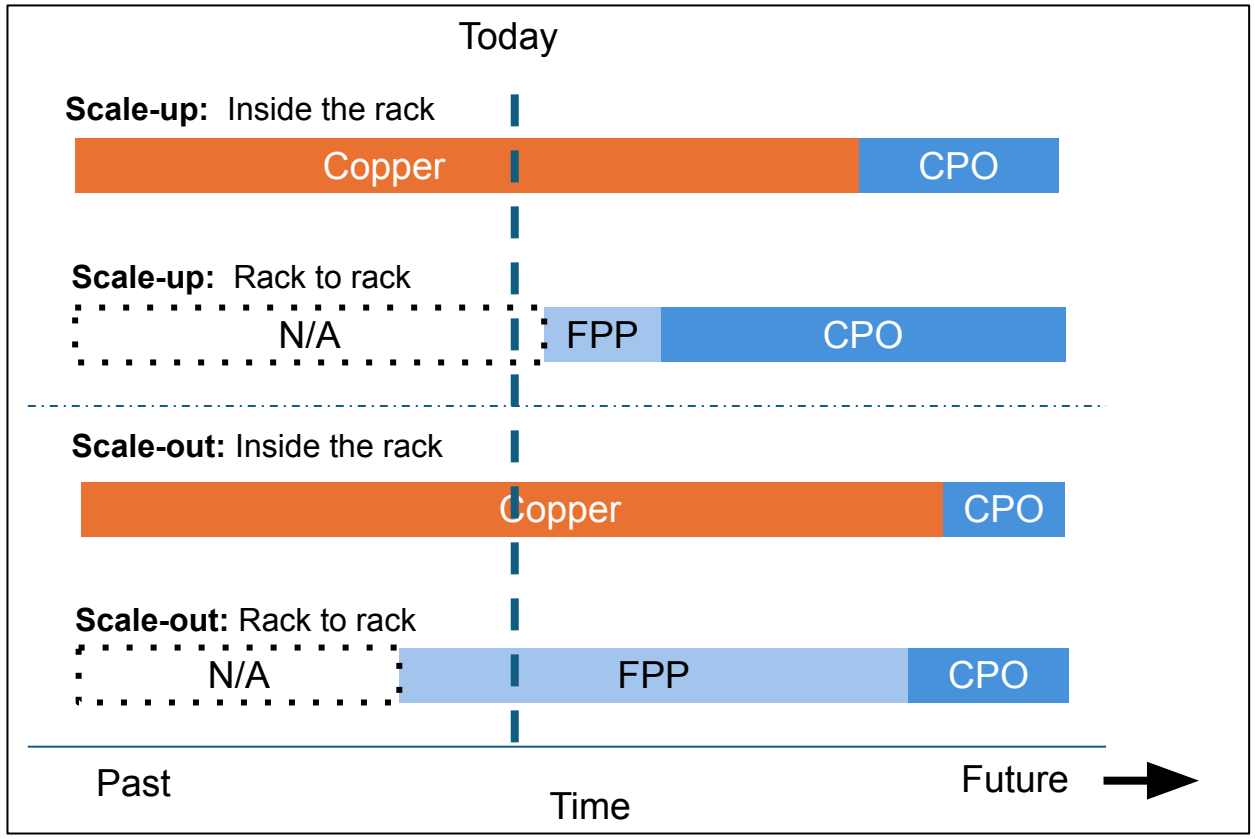
- Supporters:
  - Nathan Tracy, TE
  - Leesa Noujeim, Google
  - Howard Heck, TE
  - Rich Mellitz, Samtec
  - Scott Sommers, Molex
  - Matt Brown, Qualcomm

- Referencing slides by:
  - Kent Lusted, Synopsis
  - Alan Weckel, 650 group
  - Sam Kocsis, Amphenol
  - Leesa Noujeim, Google

From CFI

I/O Transitions for AI

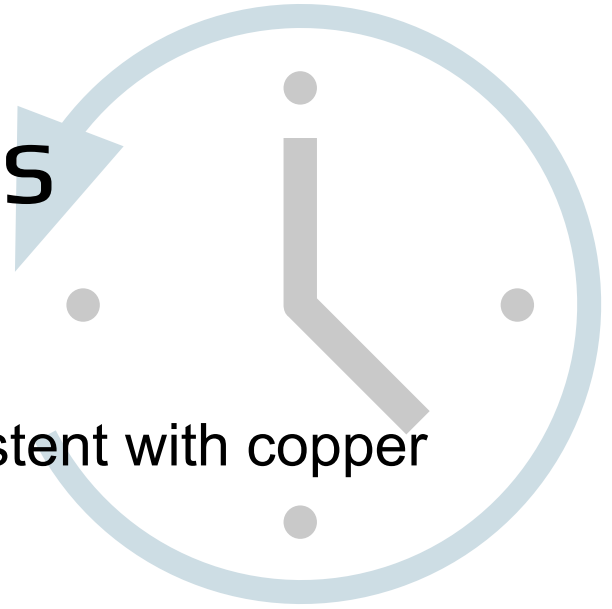
- Current and future transitions involve Copper, front panel pluggable (FPP) optics, and CPO/NPO
- Copper dominates inside-the-rack connections today but shifts toward optics over time
- Rack-to-rack connections transition from pluggable to CPO
- Market requires both copper and optical PMDs @ 400G



Based on AI Networking: What do scaleup and scaleout really mean for networking demand, Alan Weckel (650 Group), https://www.ieee802.org/3/ad_hoc/E4AI/public/25_0327/weckel_e4ai_01_250327.pdf

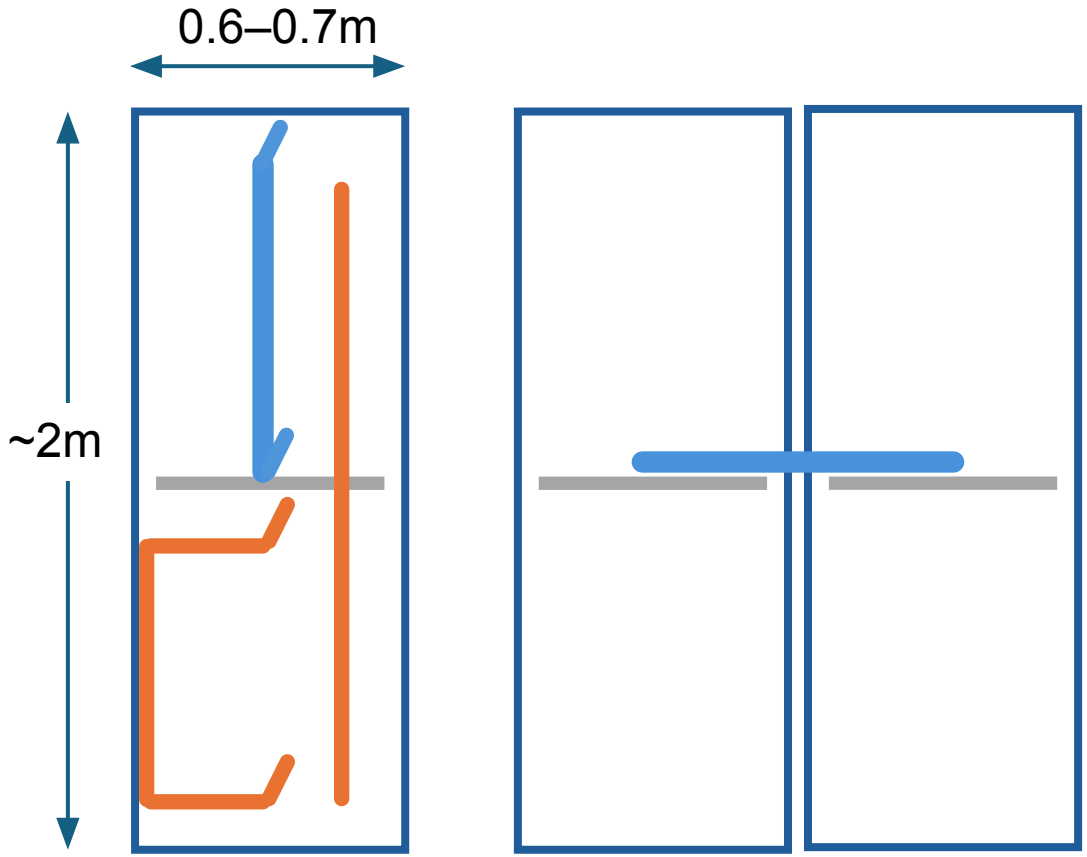
Requirements for BOTH electrical and optical PMDs

Historical Copper Cable Objectives



- 802.3bj
  - Define a 4-lane 100 Gb/s PHY for operation over links consistent with copper twin-axial cables with lengths up to at least 5m.
- 802.3cd
  - Define single-lane 50 Gb/s PHYs for operation over copper twin-axial cables with lengths up to at least 3m.
- 802.3ck
  - Define a single-lane 100 Gb/s PHY for operation over twin-axial copper cables with lengths up to at least 2 m.
- 802.3dj
  - Define a physical layer specification that supports 200 Gb/s operation over one pair of copper twin-axial in each direction with a reach of up to at least 1 meter.

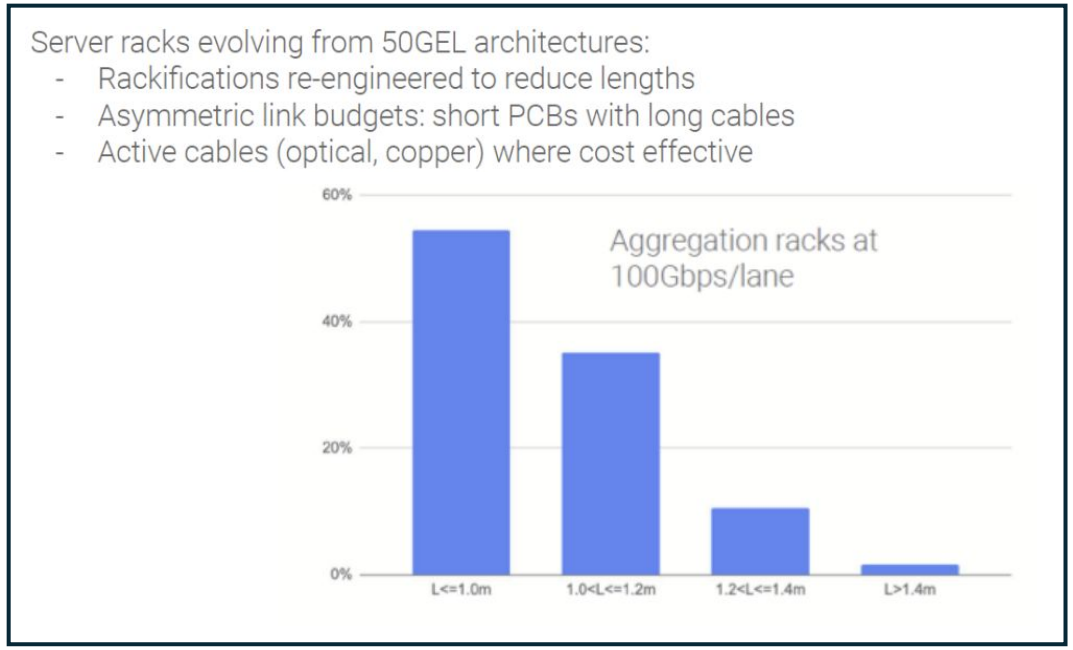
Length Need is Unavoidable



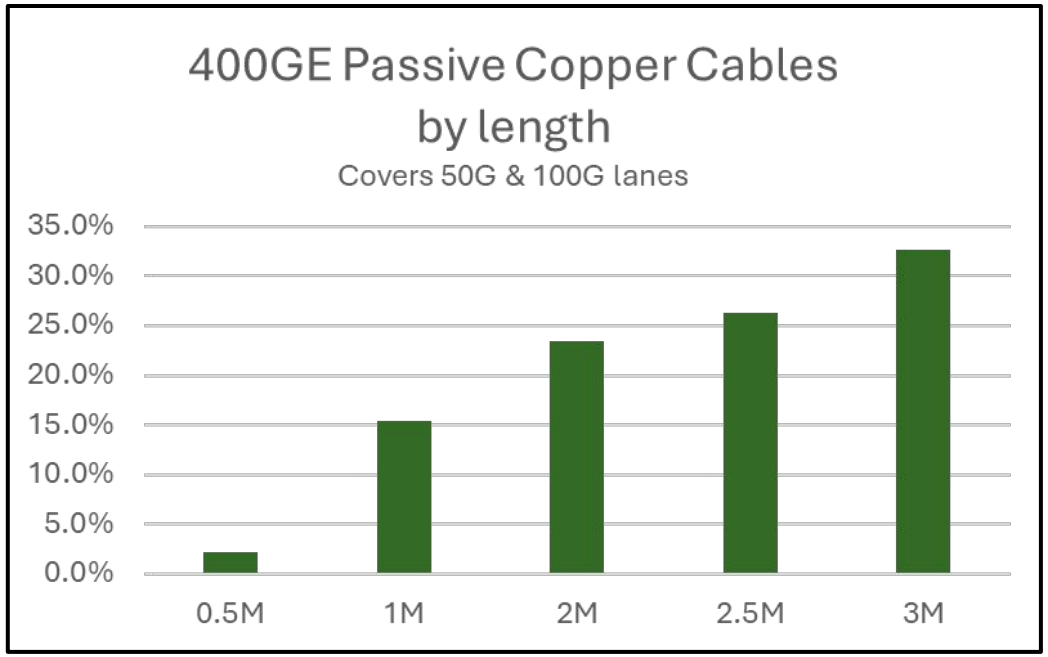
- Rack sizes remain the same
- In-rack utility
  - Middle to top/bottom intra-rack reach
  - Middle to middle+ for side by side rack to rack reach
- Remember direction change
  - 26 AWG 1.7”
  - Commonly 4-6”
- Length affects Broad Market Potential
- Suggests 1m is minimal target

Rack Examples	Cisco R42610 19” Rack - 42 Rack Units (RU) HxWxD: 2000 x 610 x 1102 mm	ORV3 Rack - 44 Open Units (OU) HxWxD: 2286 mm x 600 mm x 1068 mm

Cable Length Utilization



End User view of rack architecture, minimizing cable lengths
https://www.ieee802.org/3/B400G/public/21_07/tracy_b400g_01a_210729.pdf (slide 7)



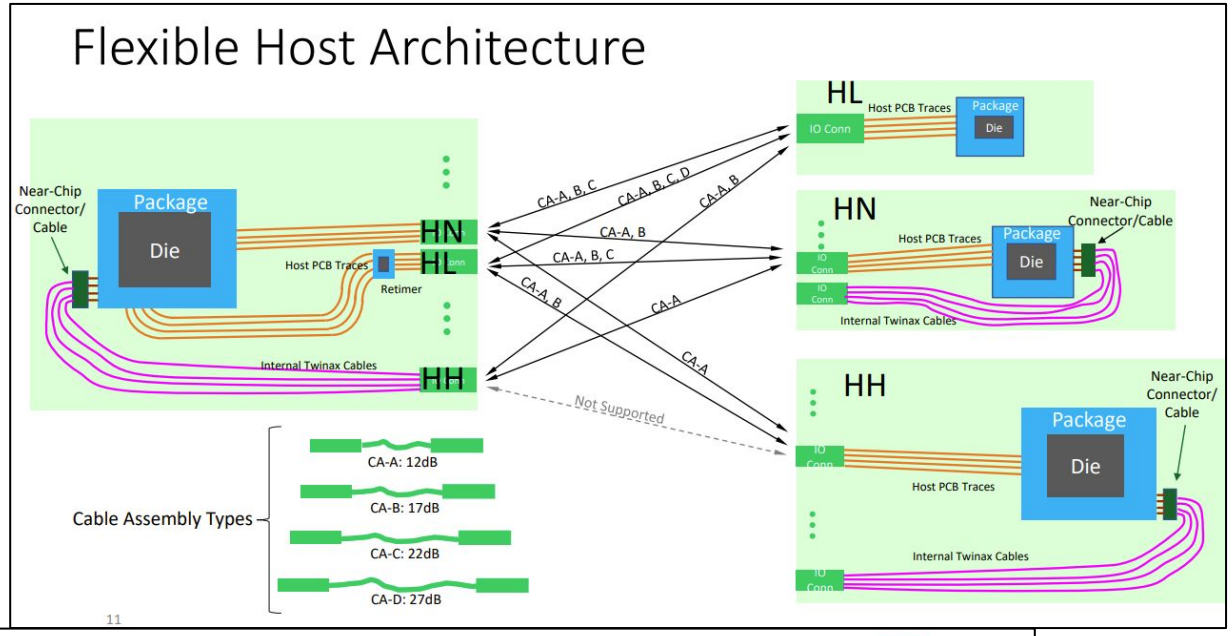
Beth's research data

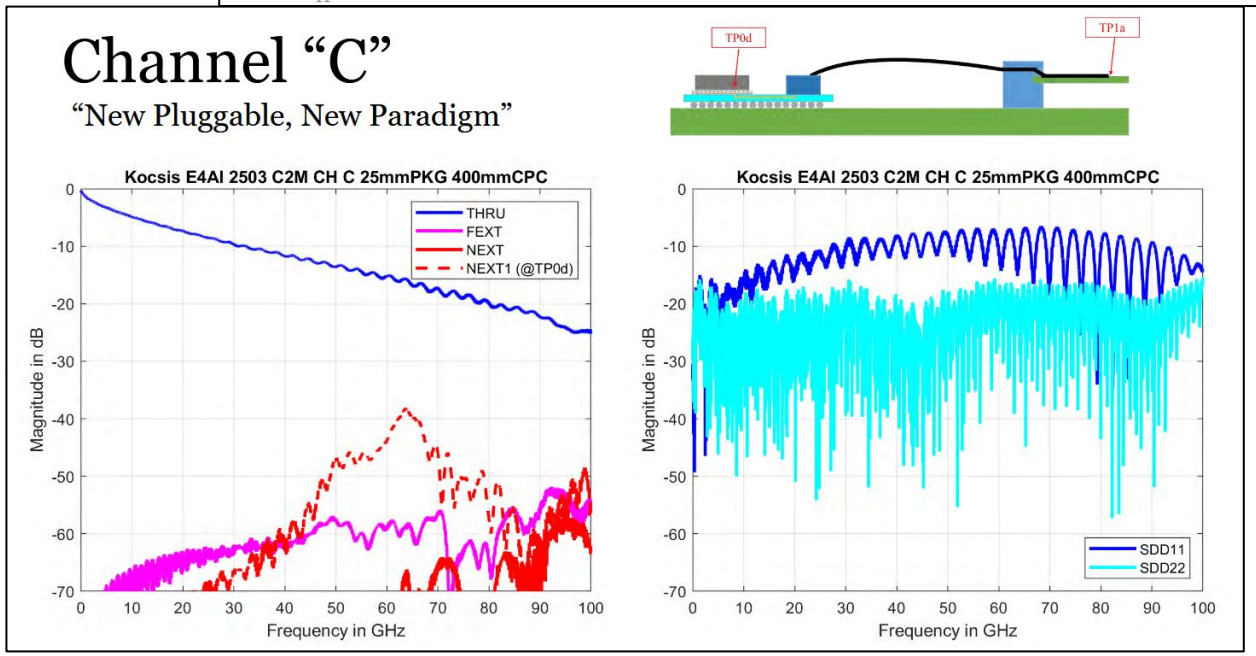
- Rising Nyquist and ASIC limitations are driving engineering creativity at all levels
- 1m as the longest target remains important for market need

P802.3dj: Adding variable host/cable lengths to the spec.
https://www.ieee802.org/3/dj/public/23_11/tracy_3dj_01_2311.pdf

Toolbox

- IEEE P802.3dj added length options based on intra-board loss
  - Not all variations have to meet the reach goal
- Tools to discuss in TF
  - Host granularity
  - Connector improvements
  - Channel improvements
  - Modulation
  - Active cables
  - Others?





E4AI: Connector paradigm shifts
https://www.ieee802.org/3/ad_hoc/E4AI/public/25_0327/kocsis_e4ai_01_250327.pdf

TF = Task Force

Considerations

- Active Copper Cables (ACC) are often used to sizably extend the reach of copper
  - If this tool is used, the target length will need to increase
- AI growth is imminent and having a passive copper solution is of value
- Other objectives are coming in future projects

Summary

- The length objective assumes front panel to front panel
- 1M objective has reasonable broad market potential
  - This is based on interconnection details
  - Not every host configuration has to achieve this
- Innovation is already in works to achieve this with passive copper
  - Decision making on the technical details is for task force
  - Ideally, active cables can achieve 2-3M (also needed in the industry)
- Recommend to adopt Copper Cable Objectives

Proposed Objectives for Adoption

- Define a single-lane, 400Gb/s PHY for operation over front panel twin-axial copper cables with lengths up to at least 1 meter.
- Define a two-lane, 800Gb/s PHY for operation over front panel twin-axial copper cables with lengths up to at least 1 meter.
- Define a four-lane, 1.6Tb/s PHY for operation over front panel twin-axial copper cables with lengths up to at least 1 meter.