A Possible Path to More Flexible Architectures and Longer Reach Passive Copper Cables

Sam Kocsis, Amphenol
Jason Chan, Arista
Jim Weaver, Arista
Kent Lusted, Intel
Mike Li, Intel
Piers Dawe, Nvidia
Richard Mellitz, Samtec
Megha Shanbhag, TE Connectivity
Nathan Tracy, TE Connectivity

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Supporters

- Leesa Noujeim, Google
- Greg Barsky, Broadcom
- Karl Muth, Broadcom
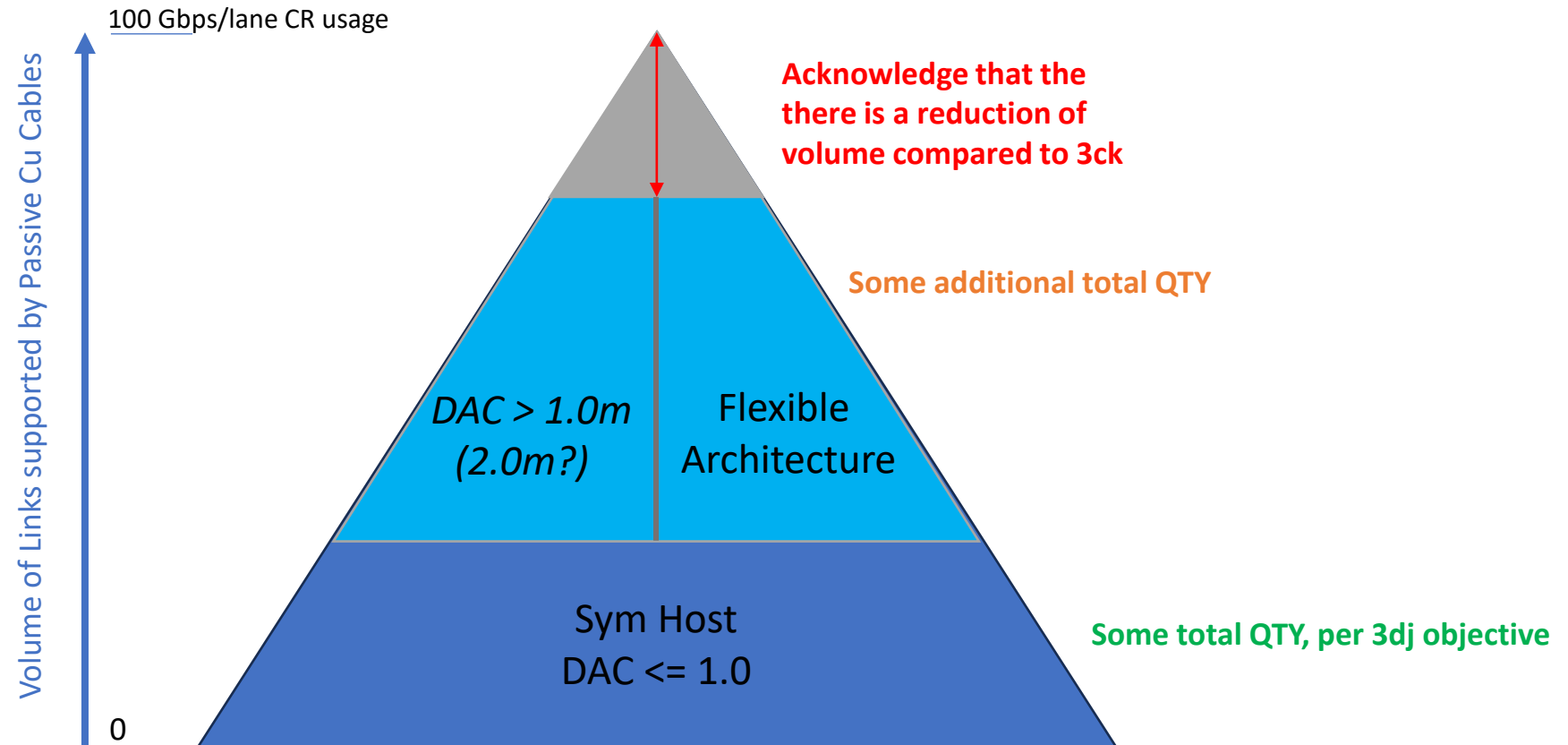- Srinivas Venkataraman, Meta

Background

- In the past, IEEE 802.3 specified only symmetrical use cases for CR links
    - "Symmetric" = the host budget for each end of the link was the same
    - Applied equally to: "Switch-to-Switch" or "Switch-to-NIC" or "Switch-to-FPGA"
        - Less impactful at lower data rates (one-size fits all)
        - More alignment between CR and C2M (deviated in ck)
- Asymmetric CR links were proposed in detail in P802.3ck
    - Advantages and Implementations considerations (dawe_3ck_01a_0721)
    - Well-received, but too late in the process to be vetted and incorporated
- An example of a symmetric host budget for 200 Gbps/lane CR PHYs was provided in diminico_3dj_01_2307
    - Symmetric continues to be an important use case, but not the only case

Asymmetric links

- "Asymmetric" = the host budget for each end of the link is NOT the same
- Well-known and deployed in the Market even at prior signaling rates
  - "Switch-to-NIC" or "Switch-to-FPGA" which are not typically symmetric
    - Loss is not equal on each end of the cable
    - Shorter PCB traces, smaller packages on NICs/FPGAs compared to Switches
  - Additional cases as well
    - i.e., Host routing distribution in a Switch, Package length distribution on an ASIC
  - Enable a wider range of useful low-power, low-cost links
  - Previous IEEE compliant definition did not allow re-allocation of losses across the link

Expanding the Broad Market Potential

100 Gbps/lane CR usage

Volume of Links supported by Passive Cu Cables

Acknowledge that the there is a reduction of volume compared to 3ck

Some additional total QTY

DAC > 1.0m (2.0m?)

Flexible Architecture

Sym Host
DAC <= 1.0

Some total QTY, per 3dj objective

0

Assume ALL 200 Gbps/lane CR implementations would fall within the 40dB die-to-die requirement, per 3dj KR objective

In the case of 200 Gbps/lane ….

- CR objective is formally adopted, objectives_P802d3dj_230518
- Higher data rates are pushing the limits of the traditional CR topologies
- Offline consensus discussions favor importance of implementation flexibility
  - Packages may take up a greater portion of the overall budget
  - Host routing needs a portion of the budget to remain practical
  - Longer passive cable links (>1m) are desired

- It makes sense to pursue an approach with more host flexibility
  - KR objective is specified as die-to-die, previously ball-to-ball
  - CR is likely to be aligned with KR, in terms of die-to-die loss
  - Flexible budget allocations of portions of the channel could enable more architectures/reaches at lower power
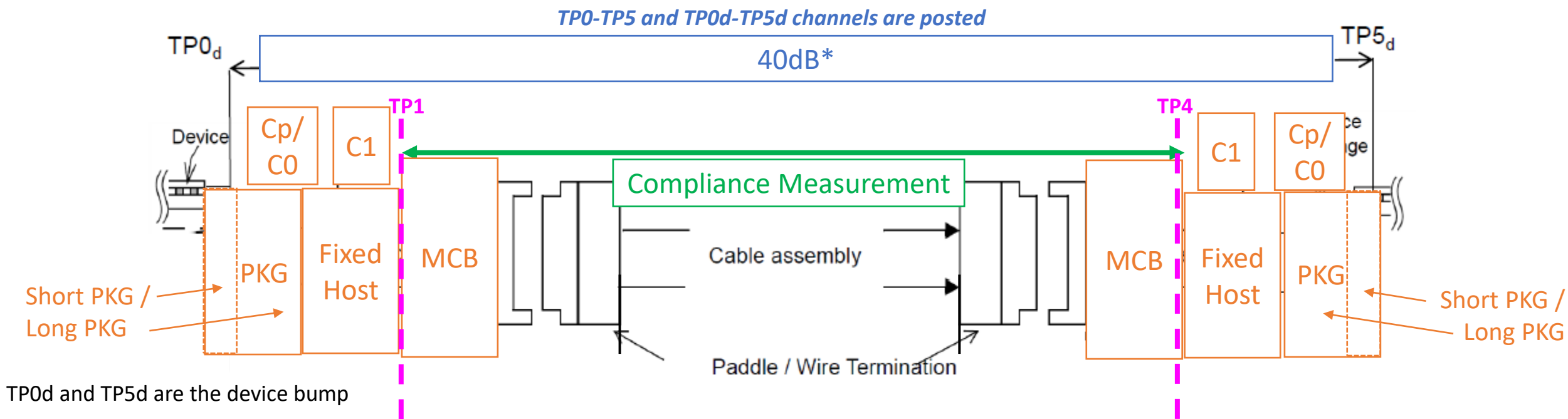
Previous/Current Path

Figure XXXA–X—TP0$_d$-TP5$_d$ insertion loss at 53.125 GHz
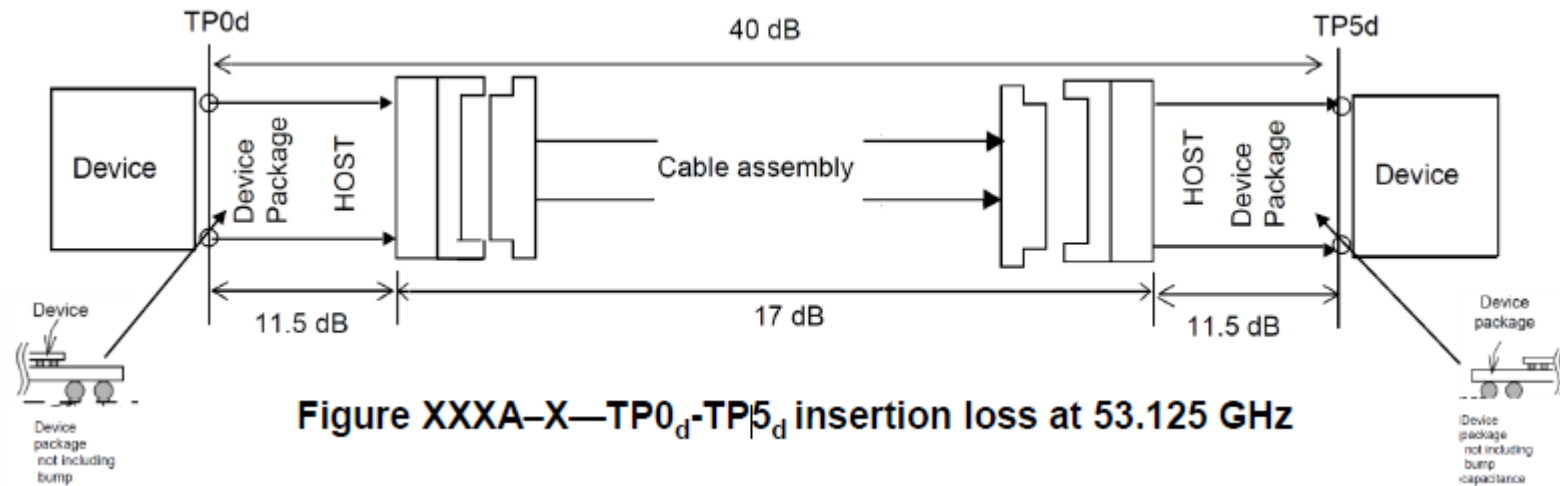
TP0d and TP5d are the device bump   From diminico_3dj_01_2307

- Each Host is allocated an equal portion of the link budget
  - Regardless of whether each Host uses it or not
- The cable assembly is allocated a fixed portion of the budget that is then developed into a compliance methodology for CR

Previous/Current Path

TP0-TP5 and TP0d-TP5d channels are posted

40dB*

$TP0_d$

$TP5_d$

Device

Cp/C0   C1

Compliance Measurement

Cp/C0   C1

MCB   Fixed Host   PKG

Cable assembly

MCB   Fixed Host   PKG

Short PKG / Long PKG

Paddle / Wire Termination

Short PKG / Long PKG

TP1

TP4

TP0d and TP5d are the device bump

- TP1-TP4 is the Compliance Measurement
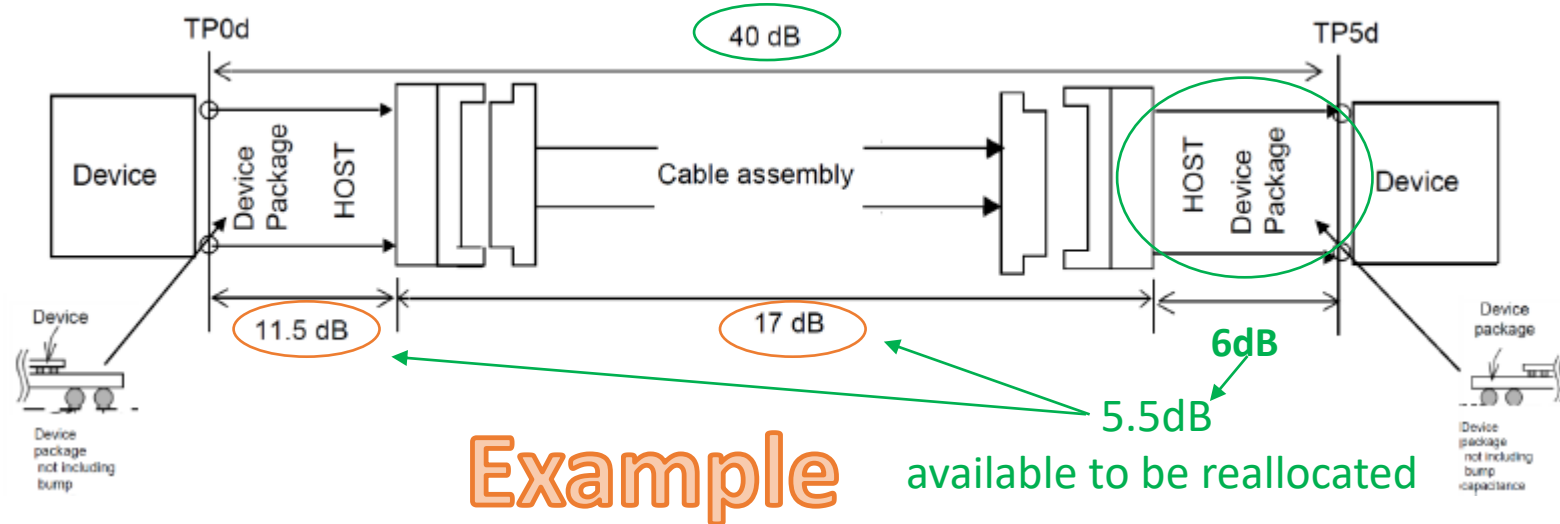- Fixed Host and two Package settings determine PASS / FAIL assembly (COM)

* A starting assumption is that it would be advantageous to align CR and KR budgets, although this decision has not been reached in 3dj yet

Maximize the Solution Space

Goals:
- Increase total use cases
- Increase reach of copper cables

TP0d and TP5d are the device bump

From diminico_3dj_01_2307

- Allow CR links to re-allocate unused portions of the symmetric budget
- Take advantage of AN and/or LT as well as cable's management registers to enable a wider range of useful low-power, low-cost links
- Enable the Device(s) on each end (both Switches and NICs/FPGAs) to determine if they can make the inserted cable work
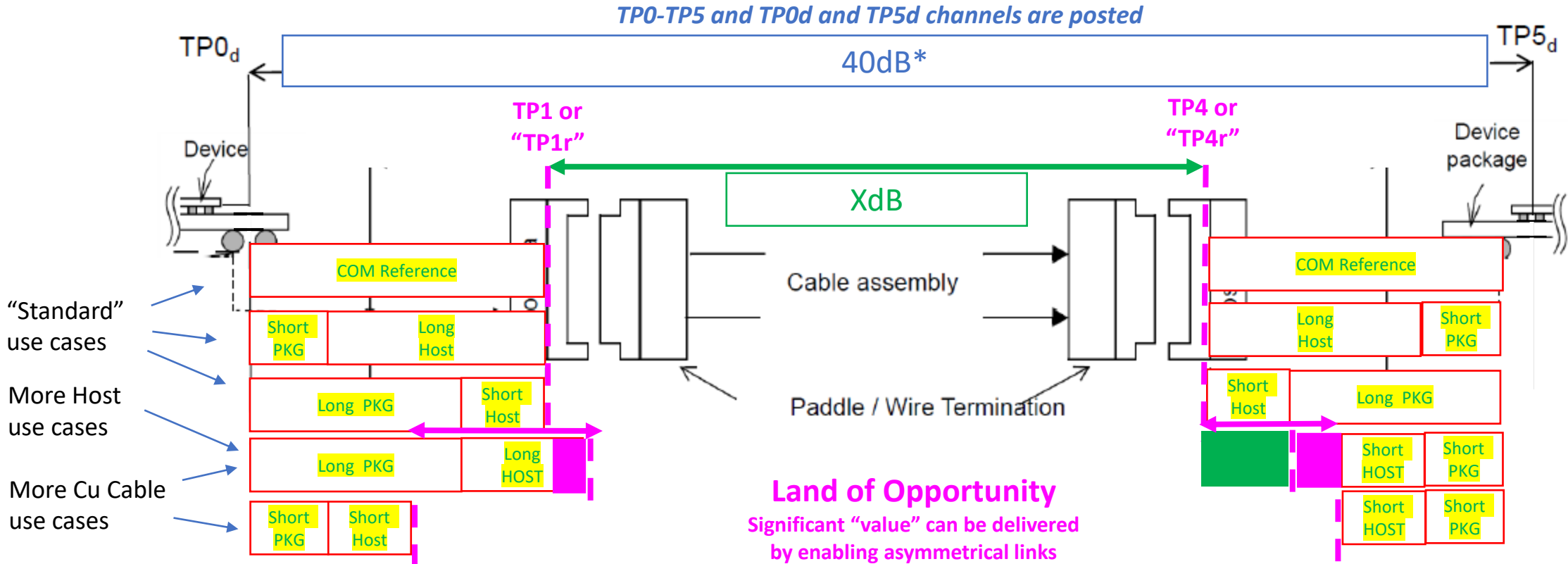
Maximize the Solution Space
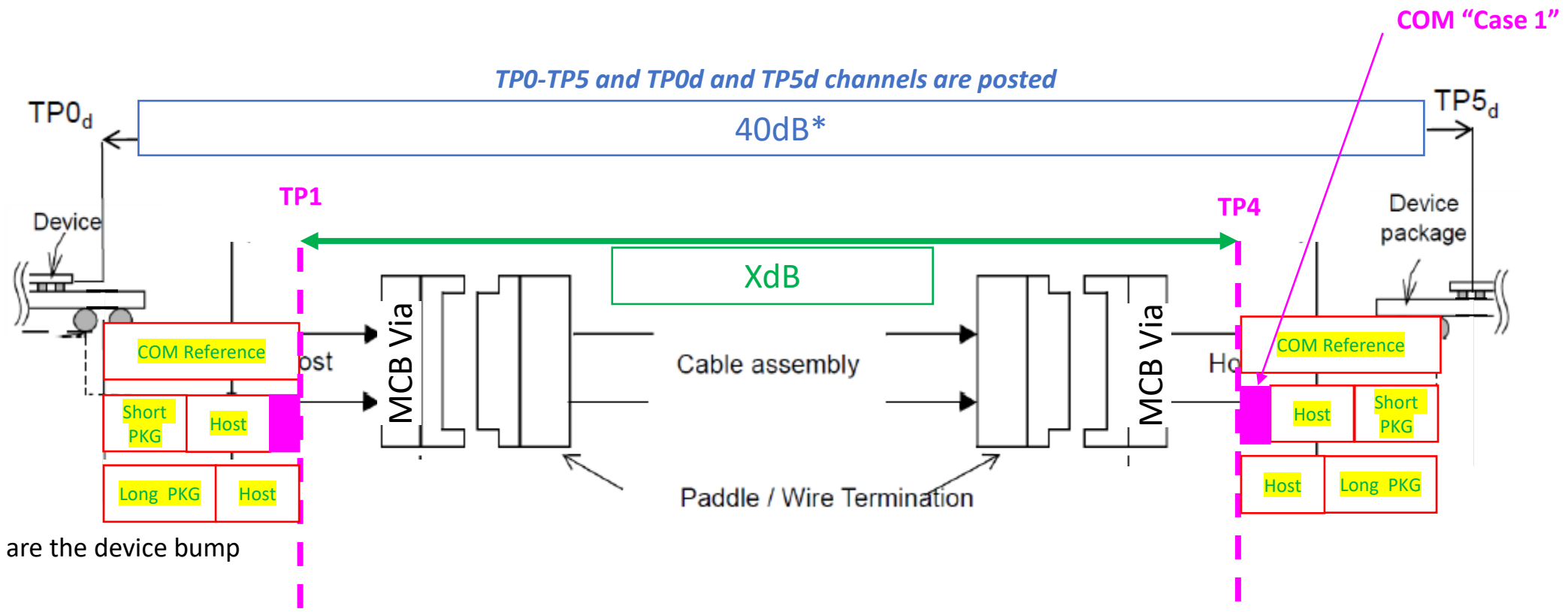
TP0d and TP5d are the device bump

- "COM Reference" = Allocation of the link budget for Host PKG + Host Routing
- Short PKG / Long PKG are used to provide boundary cases for the COM reference package, same as 3ck
- A fixed Host allocation means that the loss reallocation potential of COM "Case 1" is not used today, in 802.3ck

* A starting assumption is that it would be advantageous to align CR and KR budgets, although this decision has not been reached in dj yet

Maximize the Solution Space

Goals:

- Increase use cases
- Increase reach of copper cables

TP0-TP5 and TP0d and TP5d channels are posted

$TP0_d$ ← 40dB* → $TP5_d$

TP1 or "TP1r"   TP4 or "TP4r"

XdB

Device   Device package

COM Reference

"Standard" use cases → Short PKG | Long Host

More Host use cases → Long PKG | Short Host

More Cu Cable use cases → Long PKG | Long HOST

Short PKG | Short Host

COM Reference

Long Host | Short PKG

Short Host | Long PKG

Short HOST | Short PKG

Short HOST | Short PKG

Cable assembly

Paddle / Wire Termination

Land of Opportunity
Significant "value" can be delivered by enabling asymmetrical links

TP0d and TP5d are the device bump

- Flexibility can be implemented with a finite number of allocation possibilities
- For example: "Short Host" = MCB?, "Long Host" = Host allocation with "Short PKG"

* A starting assumption is that it would be advantageous to align CR and KR budgets, although this decision has not been reached in dj yet

Advantages of Asymmetric Links

- A growing majority of deployed links are actually asymmetric
- Allowing reallocation of portions of the budget means no "dB" are left unused
- Enabling more low power, low cost links
- Complementary to symmetrical links
- Increases broad market potential
- Methodologies also have KR potential
- etc

As of Today….

- We are starting a conversation to investigate the:
  - Value (how much longer reach and how many additional copper links could be enabled by supporting asymmetrical links)
  - Complexity (how would the implementation be allowed)
- Please reach out to join the conversation
- Stay tuned to hear more proposal details in the coming months (assuming the concepts are viable)
- Why this presentation now?
  - Early notification to enable additional conversations and facilitate consensus building
  - Identify additional use cases
  - Identify concerns
  - Eliminate surprise