

200 Gbps/lane Electrical interfaces and PMDs – Status Update

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Intro/Background

- The 100 Gbps/lane electrical interfaces and PMDs in P802.3df are (almost) complete
- Shift attention to 200 Gbps/lane electrical PMDs and AUIs

Looking at the (Recent) Past

High-level IEEE P802.3ck Influences on Host System Design include:

- Notable disparity in ILdd loss of AUI C2M host (11.9 dB) vs. CR host (6.875 dB)
 - I.e. two distinct system port types
- Two AUI C2M module output modes defined: short and long
 - And updated AUI C2M near-end and far-end eye measurement methodology
- AUI C2C management-configurable transmitter equalization, based on Cl 136.8.11 and Cl 162.8.11 PMD Control Function “link training”
- Along with numerous other improvements and adjustments

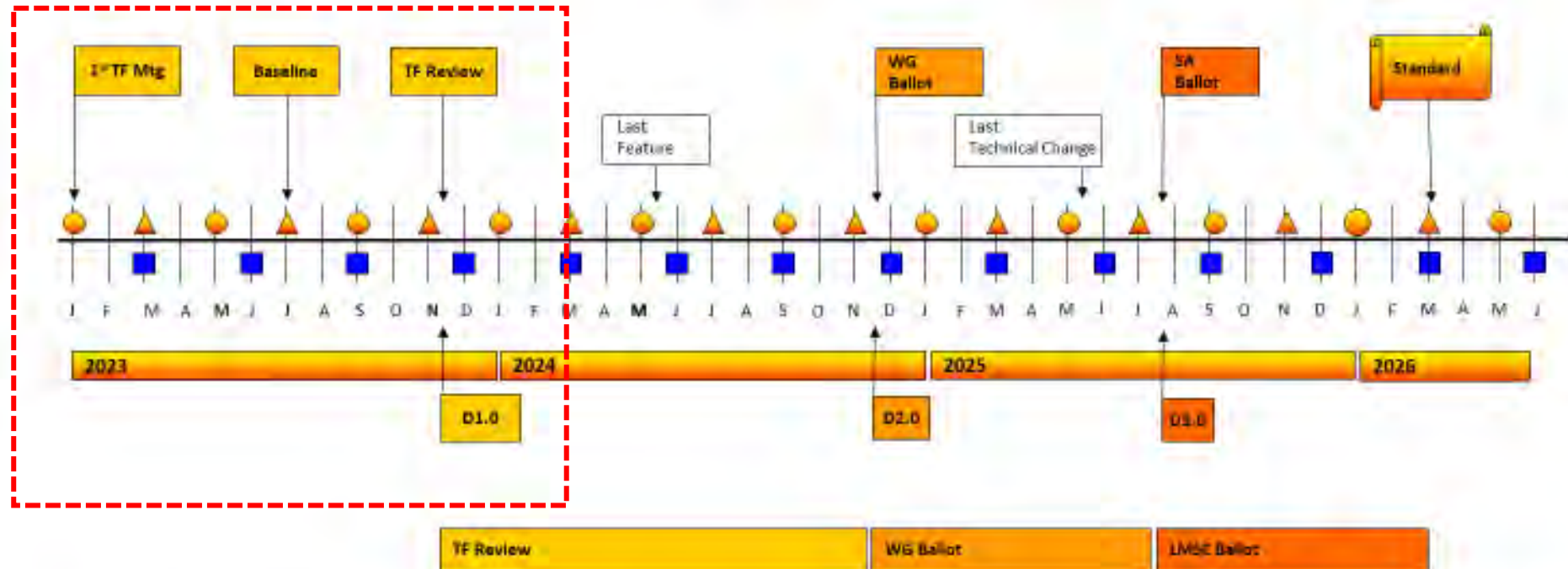
Contributed Channels Comparison

- For P802.3ck channel contributions, there were 8 backplane, 10 copper cable, 10 AUI C2M, 3 AUI C2C
 - Total of $\sim 72 + 24 + 28 + 13$ channels
- For P802.3df/dj channel contributions, there are 2 backplane and copper cable, 2 AUI C2M, 1 AUI C2C
 - Total of $15 + 24 + 2$ channels

More channel contributions are needed!!!

Why the Rush?

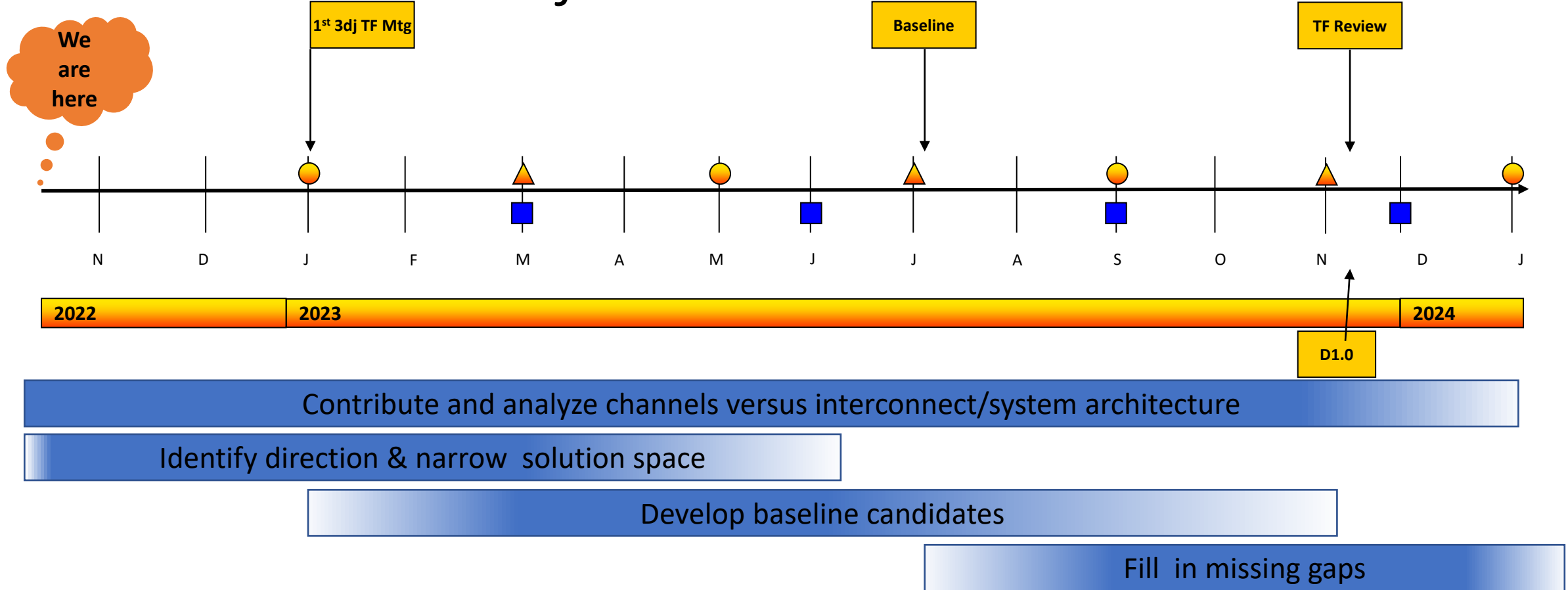
Potential IEEE P802.3dj Timeline



Note – Timeline will need to be adopted, monitored, and adapted, based on progress, by future P802.3dj Task Force.

Legend	
▲	IEEE 802 Plenary
●	IEEE 802.3 Interim
■	IEEE-SA Standards Board

Potential 200 Gbps/lane Electrical-Track Timeline to 3dj Task Force Review



Legend
▲ IEEE 802 Plenary
● IEEE 802.3 Interim
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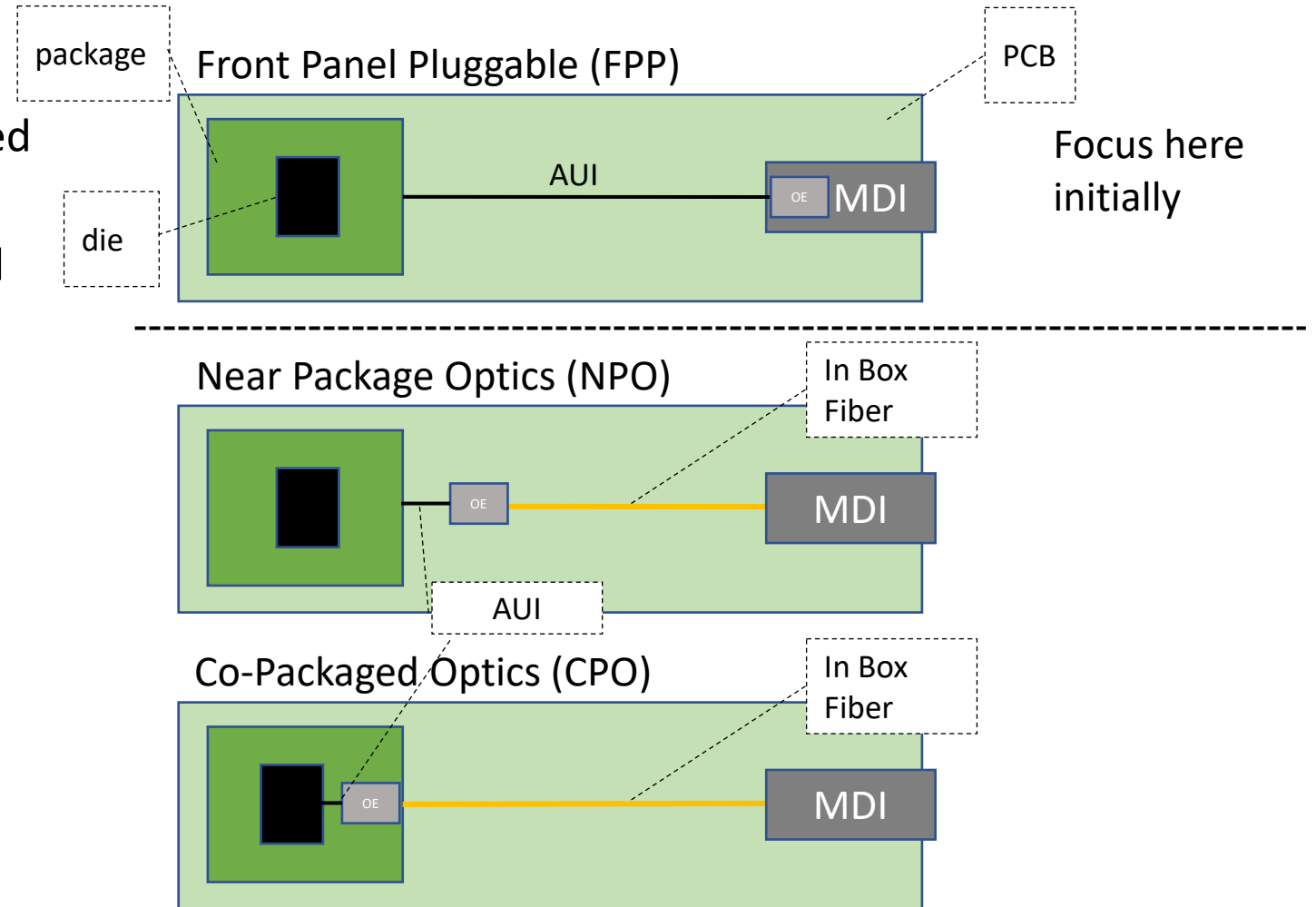
Finding A Starting Point

Initial Focus

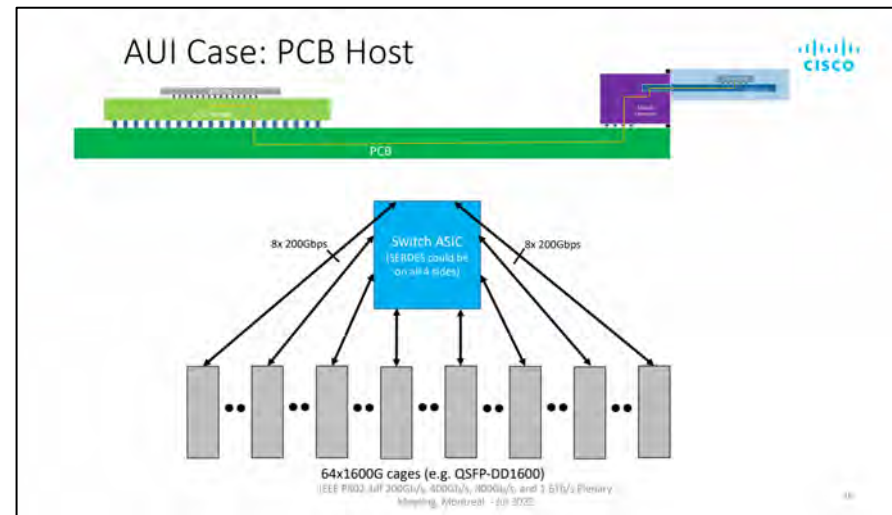
- Progressing PCS, FEC architecture, and optical PMDs is dependent on AUI interface definitions (e.g. insertion loss, pre-FEC BER target, channel effects, etc)
 - Optical PHYs are typically needed first by end users
 - Increased front panel bandwidth is needed for next generation optical modules
- Setting copper-based PMDs aside for now
 - The deployment of copper cable interfaces traditionally lags optics
 - Slightly decoupled from AUI decisions, yet similar
 - There are no 200 Gbps/lane backplane objectives adopted at this time

AUI C2M Form Factors: FPP vs. NPO vs. CPO

- Several channel contributions related to FPP form factor of AUI C2M
- No contributions specifically related to CPO nor NPO form factor of AUI C2M
- CPO and NPO form factors can be considered chip-to-module or chip-to-chip AUIs
 - CPO and NPO are different physical realizations of the “traditional” use case
 - Conceivable to optimize these AUI variants for the shorter reach/loss



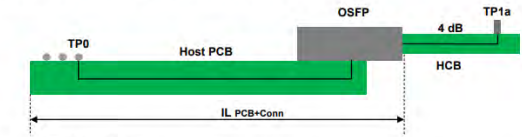
Some FPP Examples



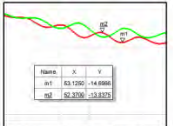
https://www.ieee802.org/3/df/public/22_07/kareti_3df_01a_2207.pdf

200G PAM4 C2M Via Length Effect Study

Structure View & Insertion Losses



- Full Structure:
 - Two adjacent channels
 - Matching segmentation meshing (i.e., common minimum element size)
 - Connector integrated with PCB
 - HCB is ideal transmission line with IL = 4 dB @ Nyquist
 - NEXT is evaluated at the ASIC model for more realistic results
- Vias = 19/67/93 mil long
- Blind Vias
- Frequency Sweep Range = 10 MHz to 120 GHz



IL @ Nyquist (53.125 GHz)

Parallel Breakout

- IL PCB+Conn = 8.24/9.32/10.31 dB
- IL HCB = 4 dB
- IL TP0-to-TP1a = 12.27/13.32/13.44 dB

Orthogonal Breakout

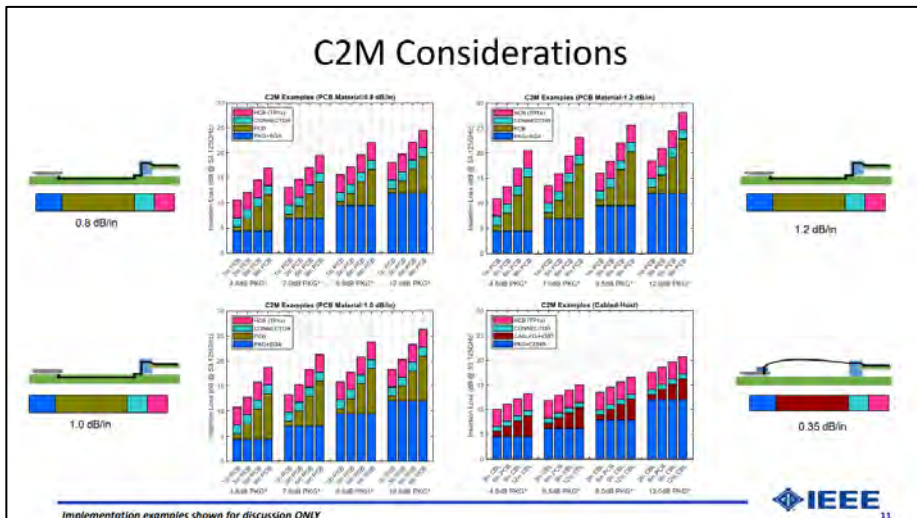
- IL PCB+Conn = 8.34/10.69/10.14 dB
- IL HCB = 4 dB
- IL TP0-to-TP1a = 12.38/14.69/14.17 dB



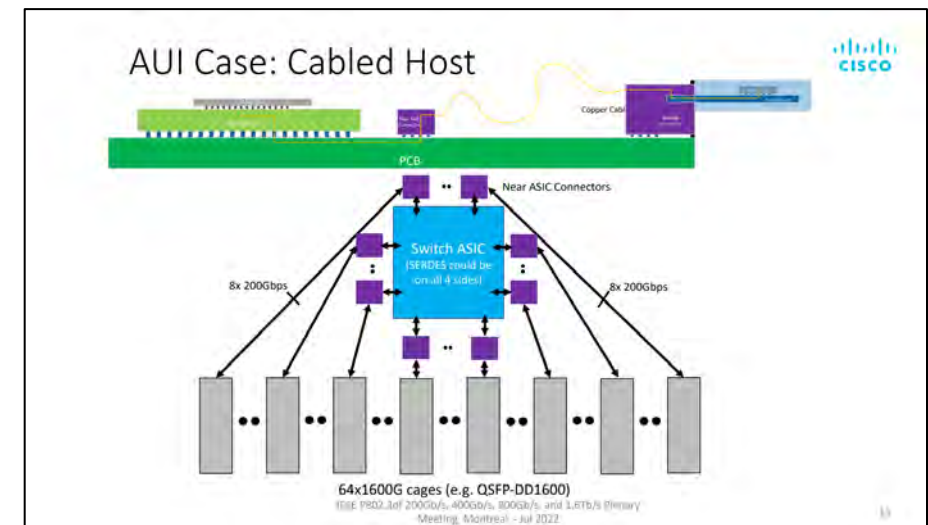
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C2M Considerations

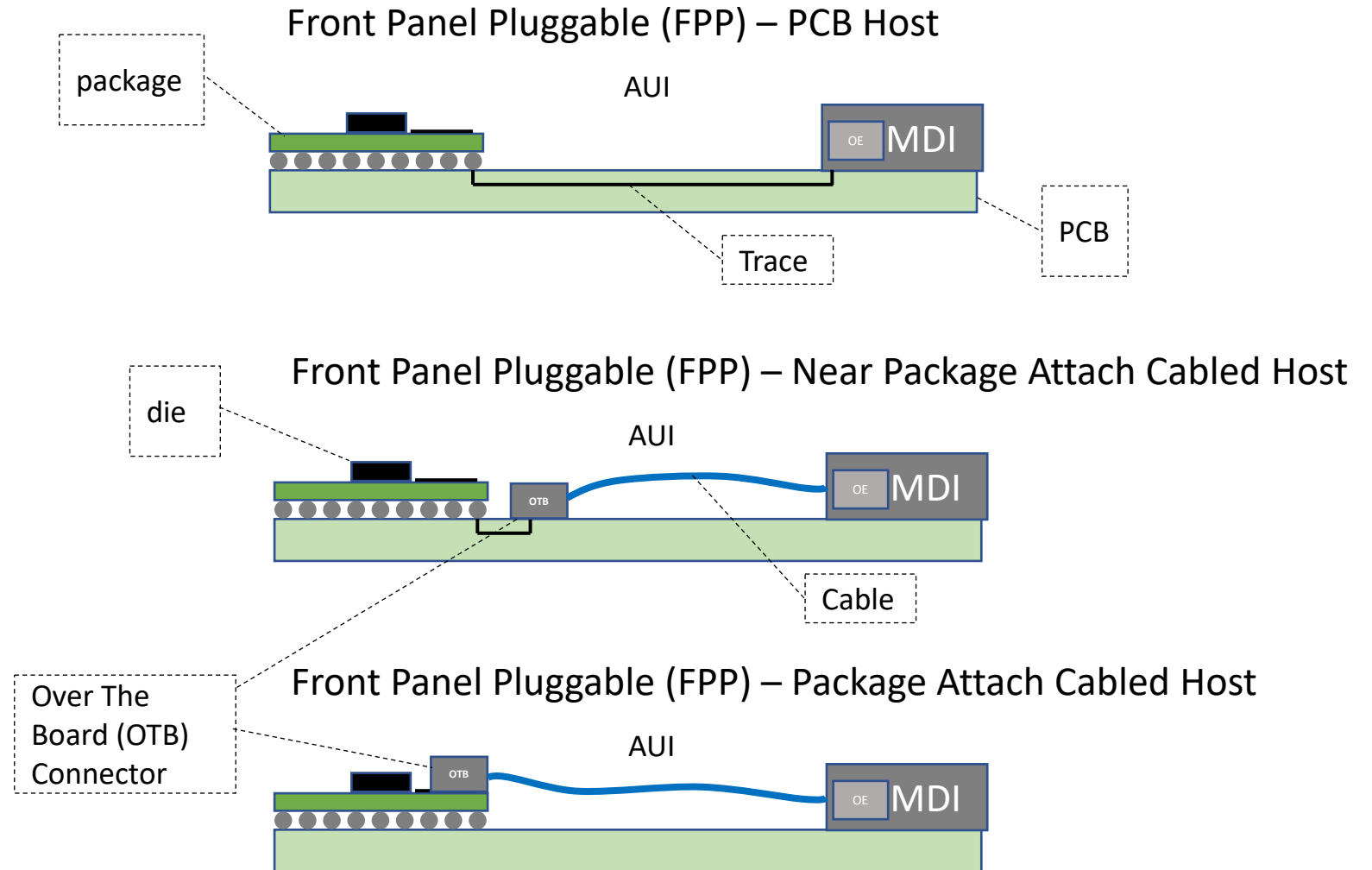


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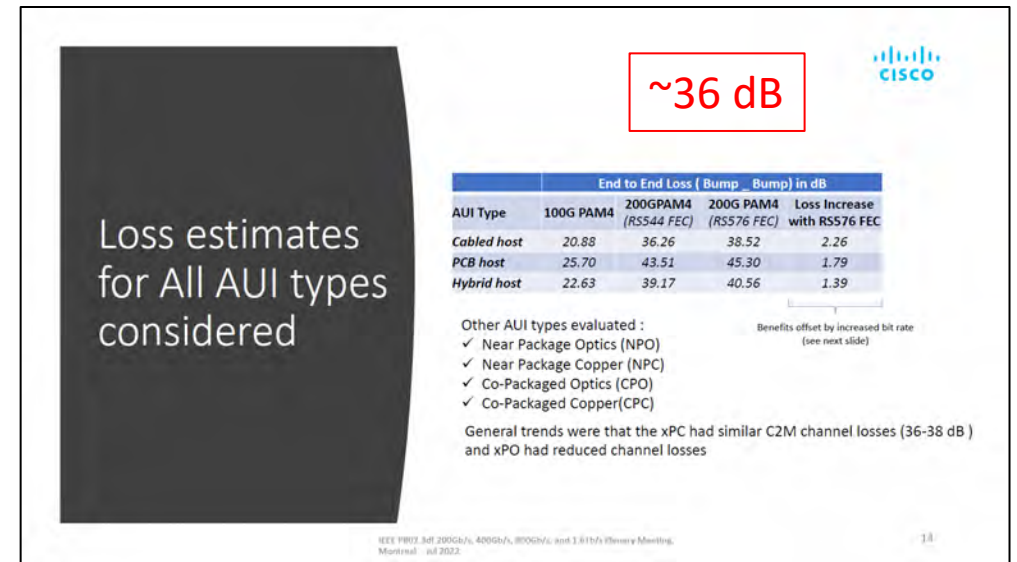
AUI C2M FPP Implementations



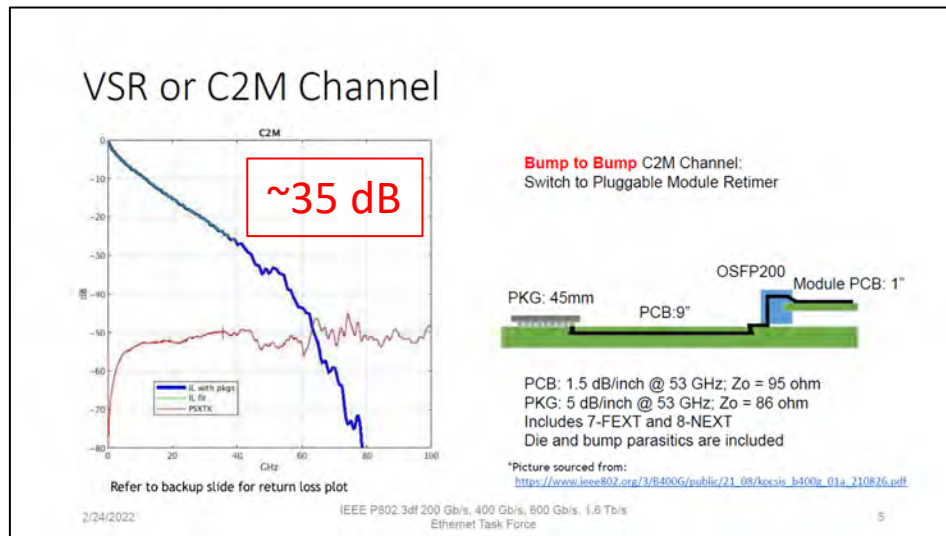
Not intended to be an exhaustive list.
Other implementations may exist.

C2M IL Targets (die-die)

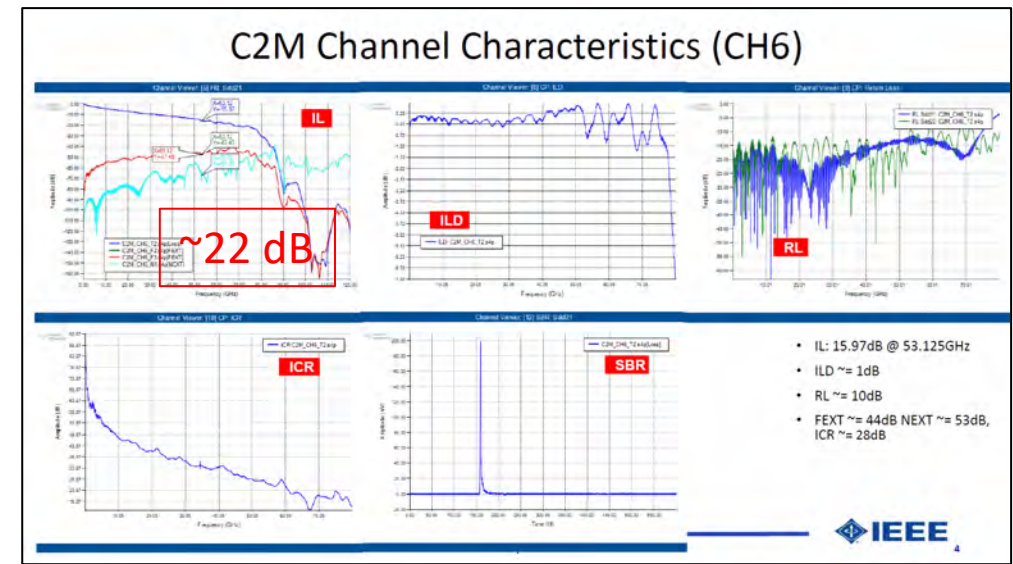
- What is the loss range?



https://www.ieee802.org/3/df/public/22_07/kareti_3df_01a_2207.pdf



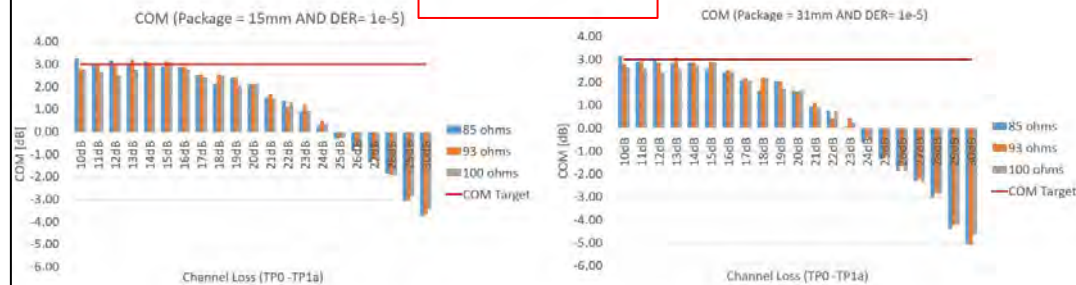
https://www.ieee802.org/3/df/public/22_02/simms_3df_01a_220224.pdf



https://www.ieee802.org/3/df/public/22_07/li_3df_01a_2207.pdf

C2M IL Targets (die-die)

Extended Channel Loss COM



COM decreases as channel loss increases

https://www.ieee802.org/3/df/public/adhoc/electrical/22_0921/akinwale_3df_elec_01_220921.pdf

C2M Channel Profile

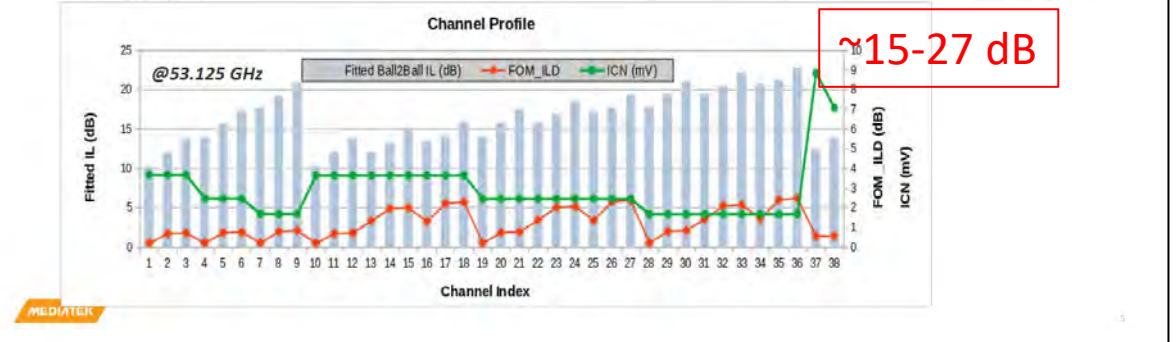
Channel variations mainly come from

- Host/Module trace length & impedance
- BGA breakout topology
- Connector transition finger connectivity
- Crosstalk

CH Index	S-Parameter File	Crosstalk	Contributor	Source
1 ~ 36		1 FEXT, 1 NEXT	C2M model from Amphenol BGA model from Keysight	OSFP200GEL
37	KEY_C2M_200G_120G_2p5HCB_022422_Thru	1 FEXT, 1 NEXT		IEEE 802.3df: rabinovich_3df_022422
38	KEY_C2M_200G_120G_4p0HCB_022422_Thru	1 FEXT, 1 NEXT	Rick Rabinovich	

The objective is to explore diverse channels to assess C2M technology feasibility

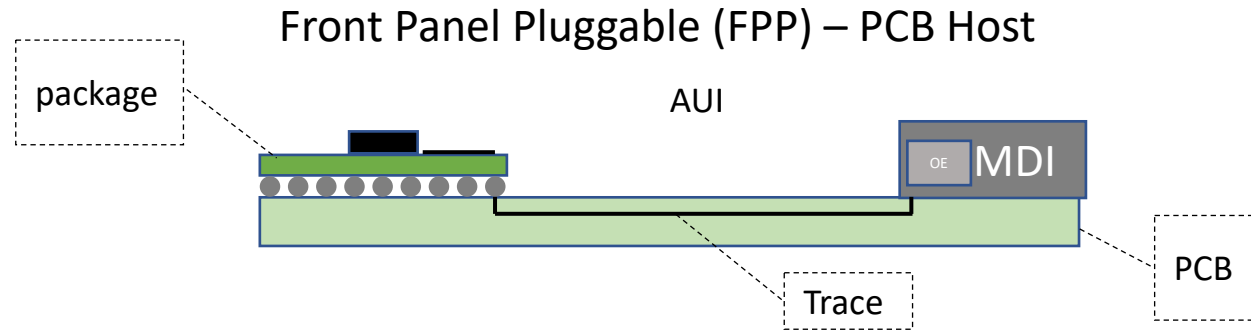
- Channel ball2ball IL: 10~23 dB
- FOM_ILD: 0~3 dB



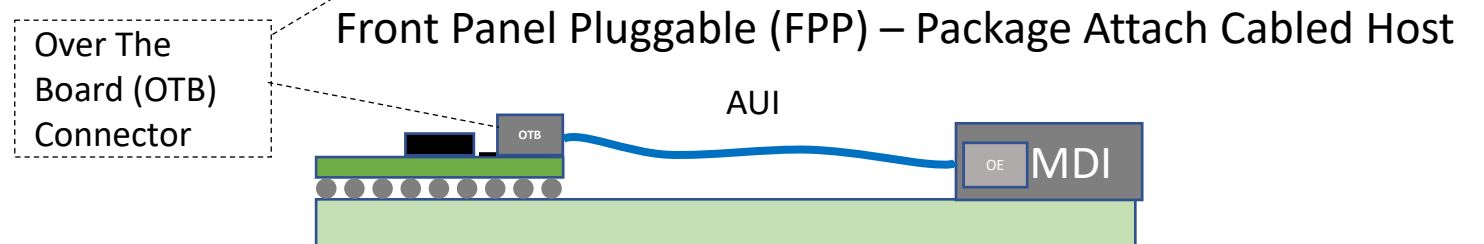
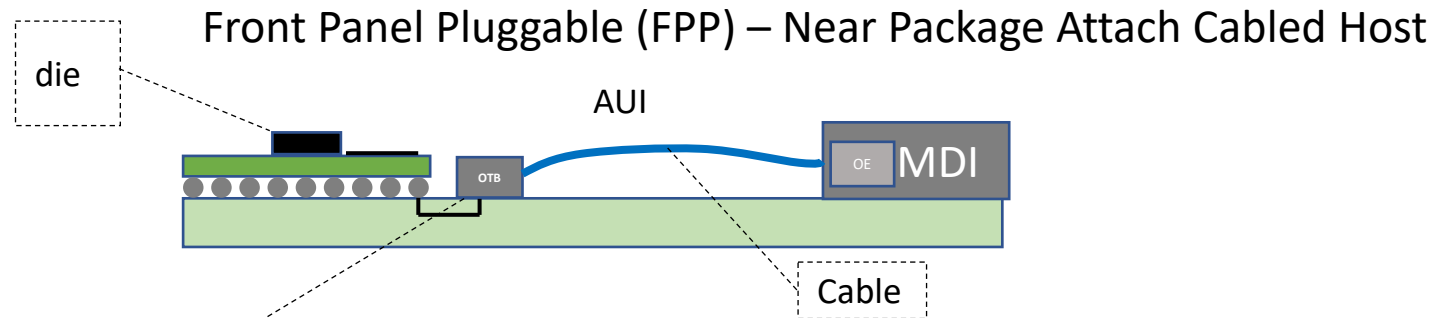
https://www.ieee802.org/3/df/public/22_03/tli_3df_01b_220316.pdf

AUI C2M FPP Observations

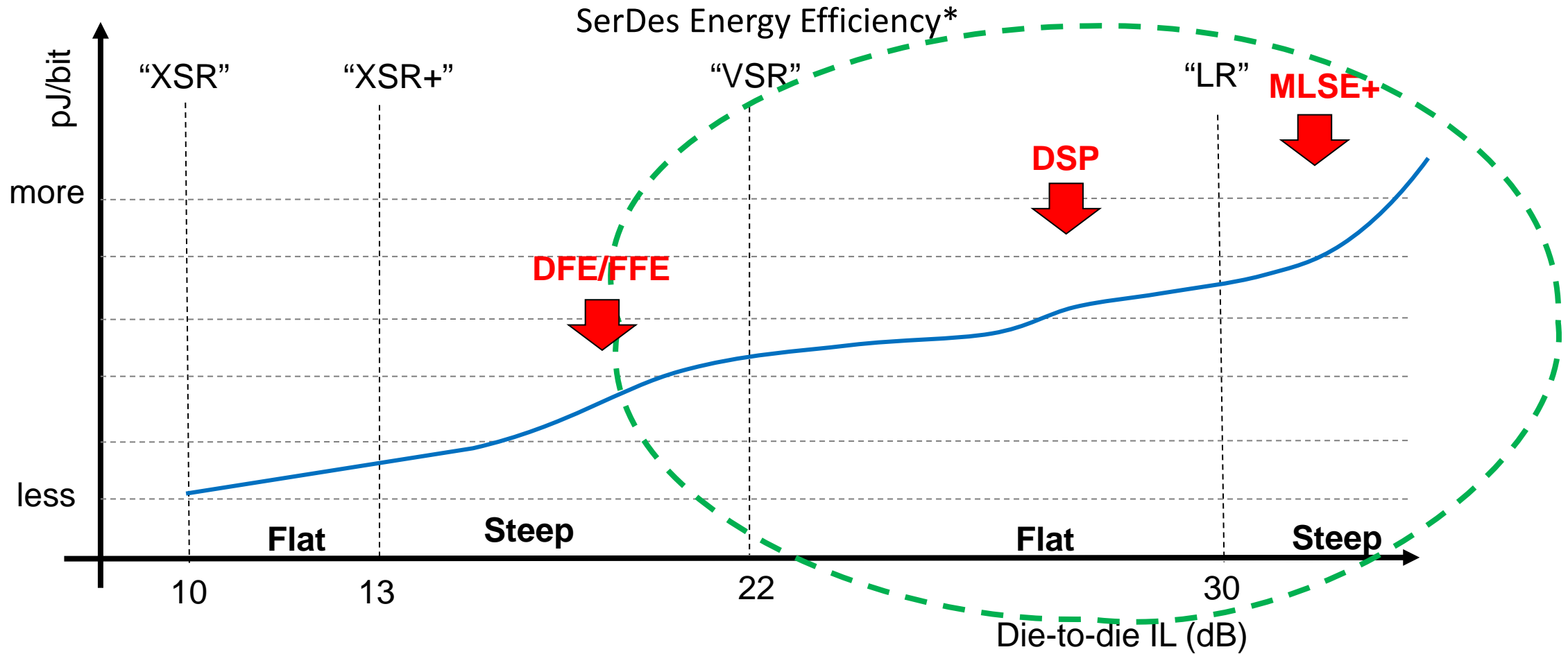
- Lower host interconnect cost with shorter in-box reach



- Higher host interconnect cost for longer in-box reach or reduced AUI power



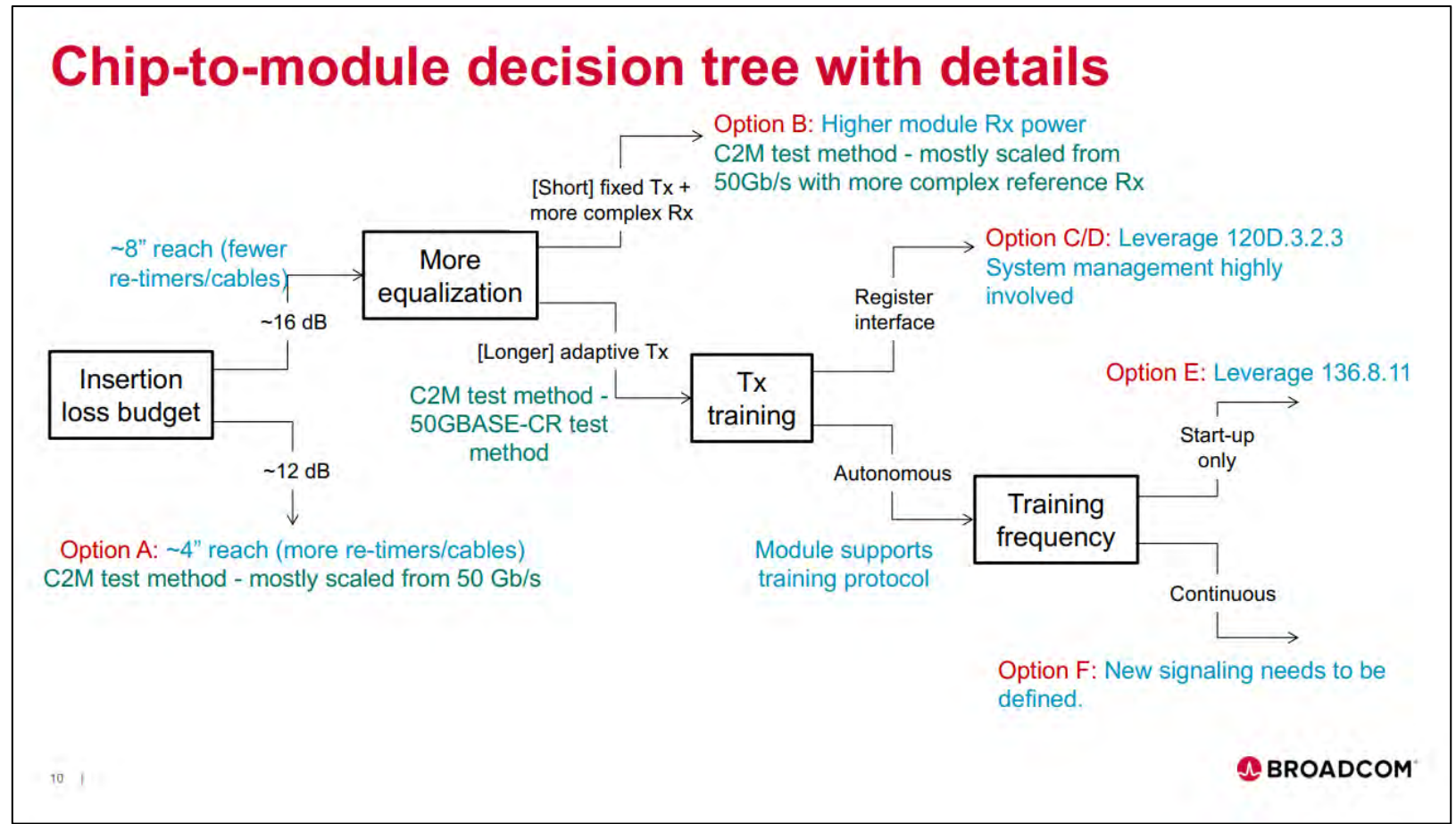
AUI C2M (die-to-die) Loss Landscape



Graph inspiration courtesy of Davide Tonietto, Huawei

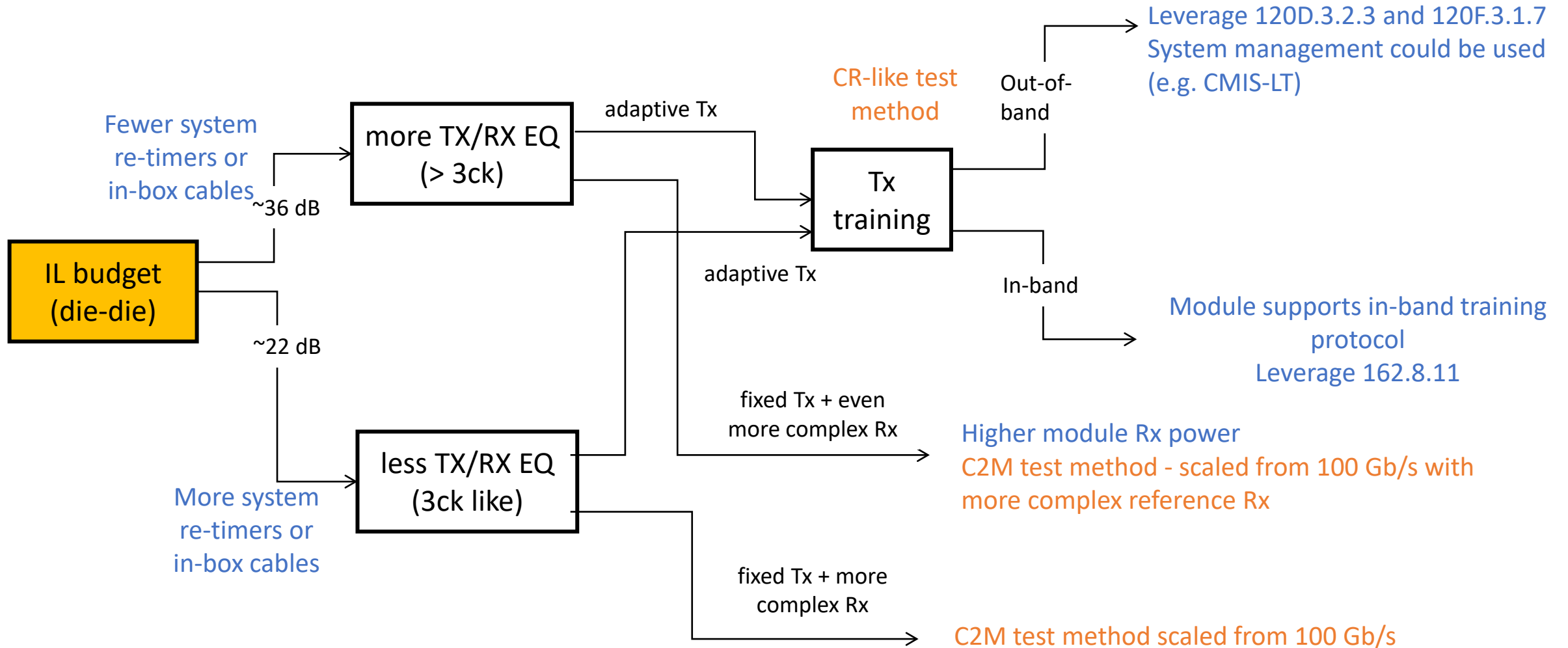
Remembering P802.3ck?

- 3ck used a decision tree to help set a C2M AUI loss direction
- Something similar could be used for 200 Gbps/lane AUIs

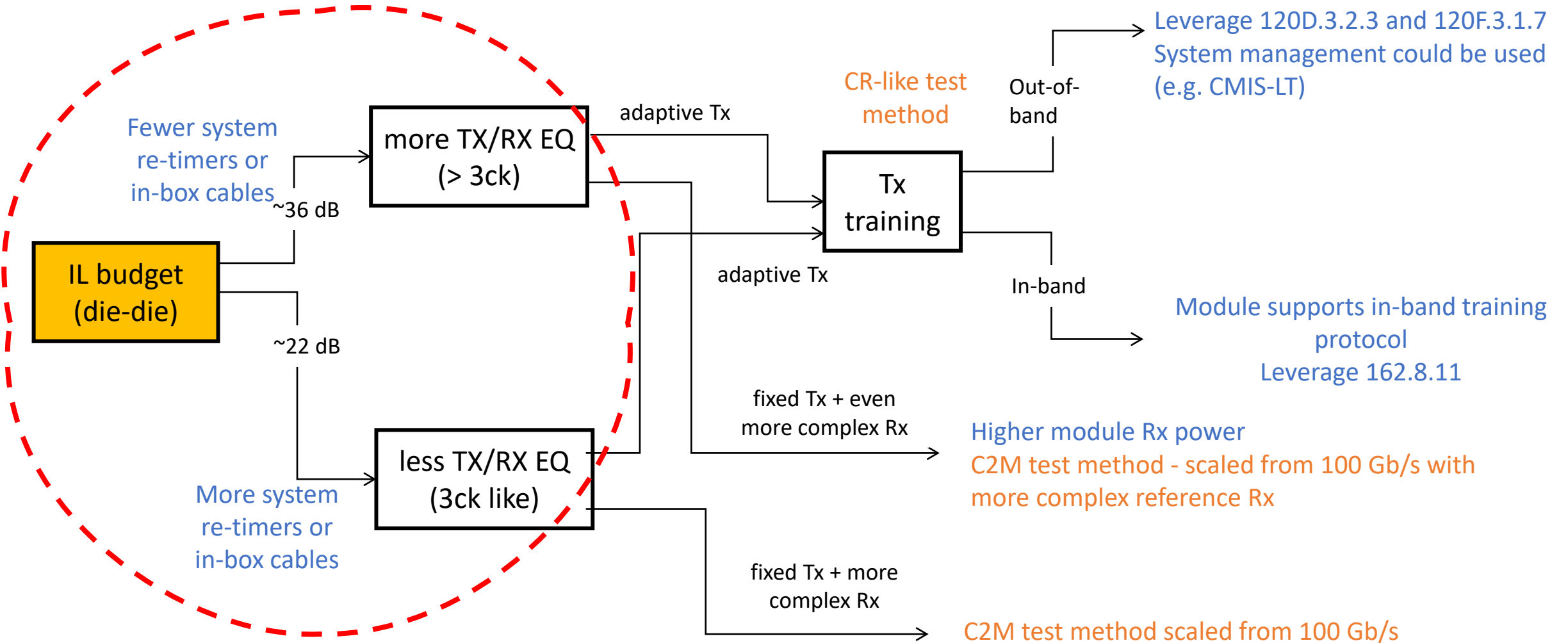


https://www.ieee802.org/3/ck/public/18_09/slavick_3ck_02_0918.pdf

3df/3dj AUI C2M Decision Tree



3df/3dj AUI C2M Decision Tree



First Step of our Journey

Summary

- P802.3ck electrical decisions influenced system design
- Roughly 1 year until first 3dj Task Force review
- To progress PCS, FEC architecture, and optical PHYs, the initial focus should be AUIs
 - Front panel pluggable specifically
- Assessing the AUI C2M loss direction is a first step
 - There are tradeoffs to make

Thanks!

Straw Poll

- For the front panel pluggable use case, I would support a 200 Gbps/lane AUI C2M die-to-die insertion loss maximum of:
- (a) 22 dB (3ck AUI C2M like)
- (b) 36 dB (3ck CR/KR like)
- (c) need more information
- A: , B: , C:
- Pick one