# CP2PUNB Qualitative Analysis

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# History

- Yair and Christian developed a worst-case link segment model, including 4 connectors, cabling and cordage 7/13 – 11/13
- Yair proposed an equation to describe this model 11/13
- Error in connector calculation corrected 7/14, 6% proposal changed to 7.5% to keep math consistent
- Several analyses have been run that confirm the accuracy of this corrected equation given the same initial conditions
- There is general agreement that this equation will be used in future E2EUNB calculations
- **The question now: how to express this data in the spec?**

# Two Competing Approaches

- Yair has proposed:
  - 4P pair operation requires the specification of resistance unbalance...not greater than 100 milliohms or 7.5% whichever is greater. (adhoc meeting #12)
- Jeff has proposed:
  - 5% + 0.1 ohms for a 4 connector channel (heath_03_0714.pdf)

# “Single-Value” Proposal

- Yair’s proposal is a mask (use_cases_rev_6, p.16) with a 25% spec below 0.1ohms P2PUNB and 7.5% above 0.1ohms
  - This reduces to a single 7.5% spec with more than about 1m of cable: easy to read
  - The 7.5% number is not recognizable to a casual reader and can be misinterpreted as a cabling-only mismatch spec
  - The 7.5% spec overestimates the imbalance for 100m cables (vs. ~5.5% in Jeff’s proposal) at a cost of about 1W potential PD power (see Annex)

# Equation Proposal

- Jeff's proposal (when correctly written) is an equation that matches Yair's worst-case curve
  - The equation is a function of cable length - it does not provide a single numeric spec
  - The terms in the equation map directly to physical parameters of the connectors and cable – it is intuitive
  - There is no excess margin with 100m cable, so a PD can be spec'd ~1W (~1.7%) higher with this proposal

# Maximum PD Power

- Unless worst-case connector P2PUNB limits power with short cables*, the PD power limit is set by Icut at the longest allowable (highest resistance) cable – just like in AT

  *Statistical analysis suggests the extreme connector mismatch case is *very* unlikely

- The 7/14 change in the proposed single-value spec from 6% to 7.5% overestimates the cable unbalance by ~1.7% (from ~0.4%) – it matters more now
- All numbers in this presentation are TBD pending final data from TIA/ISO/other cable data providers

# Key Decision Points

- Single-Value proposal is easier to read
- Equation proposal refers more directly to cable and connector parameters
  - I claim these first two are a wash… but:
- Equation proposal allows us to spec ~1W more power at the PD
  - If we write the remainder of the PSE and PD specs to take advantage of the extra 1W, we should use the equation
  - If not, the single-value spec is adequate (with a note clarifying that the cabling component is 5% max)

# Annex: PD Power Derivation

**Analysis:**

$$R\max = Rnom(1 + Rtol)$$

$$R\min = Rnom(1 - Rtol)$$

$$Vcable = I\lim * R\min$$

$$Icable@R\max = \frac{Vcable}{R\max} = I\lim\left(\frac{1 - Rtol}{1 + Rtol}\right) < I\lim$$

$$PDpower = (I\lim + Icable@R\max) * (Vpse - Vcable) = \frac{2I\lim}{1 + Rtol} * (Vpse - I\lim * Rnom(1 - Rtol))$$

**Using Vpse=50V, Ilim=0.6A, Rnom=0.9Ω*100m:**

$$PDpower(Runb = 5.5\%) = \frac{2 * 0.600}{1.055} * (50.0 - 0.600 * 9.00 * 0.945) = \frac{1.2}{1.055} * 44.9 = 51.07$$

$$PDpower(Runb = 7.5\%) = \frac{2 * 0.600}{1.075} * (50.0 - 0.600 * 9.00 * 0.925) = \frac{1.2}{1.075} * 45.0 = 50.24$$