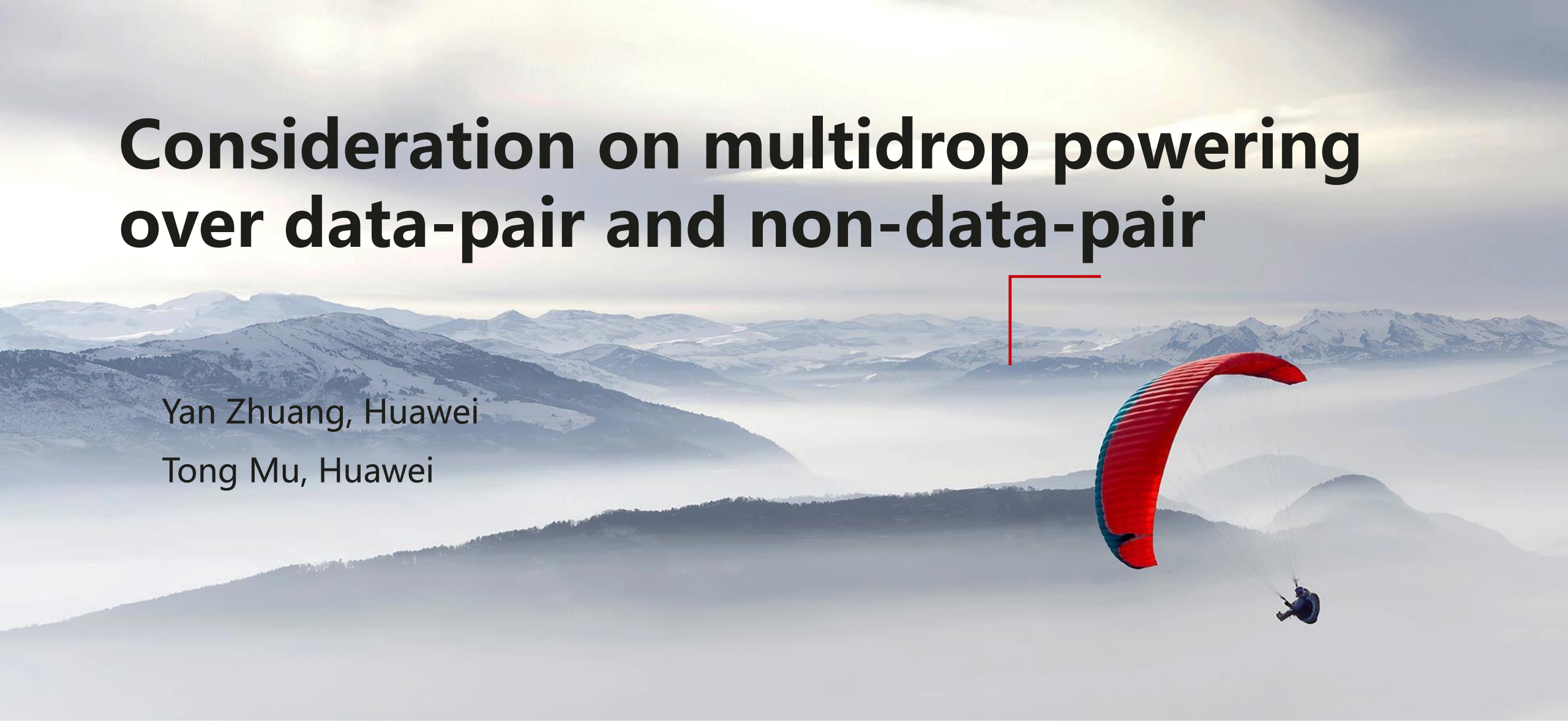
Consideration on multidrop powering over data-pair and non-data-pair



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Multidrop powering proposals @data-pair

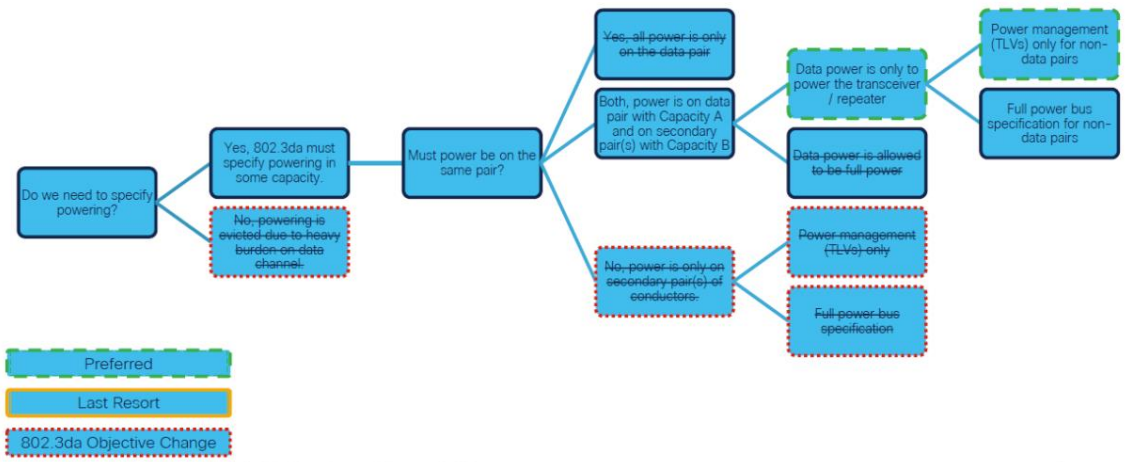
So far, we have the following SPMD power supply related proposals:

- stewart_01_0720: Propose a simple vote to determine if PDs of various “types” are present
- cjones_01_082620v1, cjones_01_092320: Propose a power up and PD removal scheme for SPMD
- paul_01_da_120220, Paul_01_da_121620: Give analysis of power coupling inductance and droop
- paul_01a_da_012721: Propose to use ‘Tokens’ to decide power classes
- paul_01_da_022421: Give analysis of PSE power output
- paul_01_da_051921: Give analysis of startup sequence
- cjones_01_052621: Give further discussions of proposed SPMD power up procedure
- Paul_da_082521: Give analysis of power coupling networks Cnode
- paul_01_da_09142022: Provide basic parameter estimations for power development

Review of the power solution decision tree

Source: https://www.ieee802.org/3/da/public/0722/SPMD_Potterf_Open_Issues_2022-07-11_PostDiscussion.pdf

Power Solution Decision Tree



Contribution to IEEE P802.3da 10 Mb/s Single Pair Multidrop Segments Enhancement Task Force 5

IEEE P802.3da SPMD Task Force - Sept 2022 Interim 7

Power Solution - (Already down to one branch, details needed)

- Minimal Data-Pair Power + Non-Data-Pair Power
  - Next step – need presentations on detail
  - How much power on data pair – need proposals
    - Feasibility (Economic & Technical) - Analysis on circuits, e.g., inductor sizing
    - How much power per node (data and non-data)… need proposal and how to specify
    - Architecture (and how it impacts power delivery)
      - What might be on the wiring side of the isolation barrier
      - How does a node connect into the mixing segment (tapped, in-and-out, ?)
      - Is non-data-pair power pt-to-pt or multidrop? Does that impact control
- Power control & management
  - Needs proposal on power management TLVs/hooks
    - Minimal control vs. envisioning many possibilities
- Process may benefit from having strawman ‘defaults’ on some of these which are more easily achieved… (for discussion)

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zimmerman_3da_01_09142022

How to achieve multidrop power supply over both pairs?

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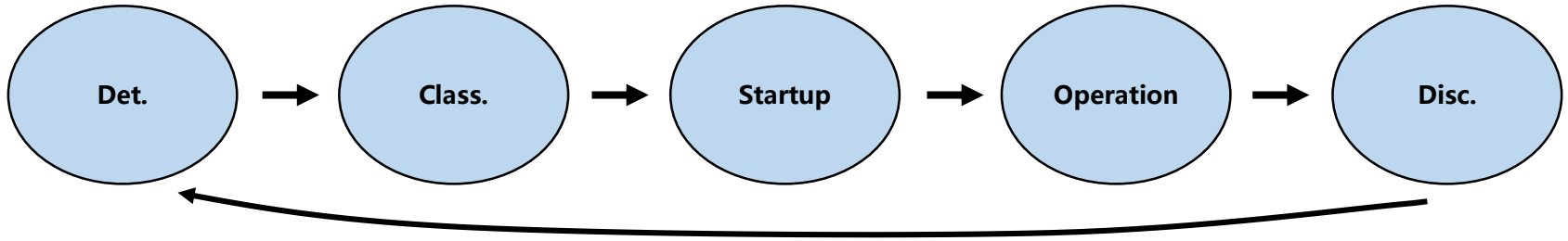
P2P power solution @data-pair



For 4-pair PoE:

- PD detection is done via detecting voltage sent by PSE and current returned from PD.
- After validated detection, classification is done via classifying voltage sent by PSE and current responded from the connected PD.
- Also, PD classification can be optionally achieved by LLDP.

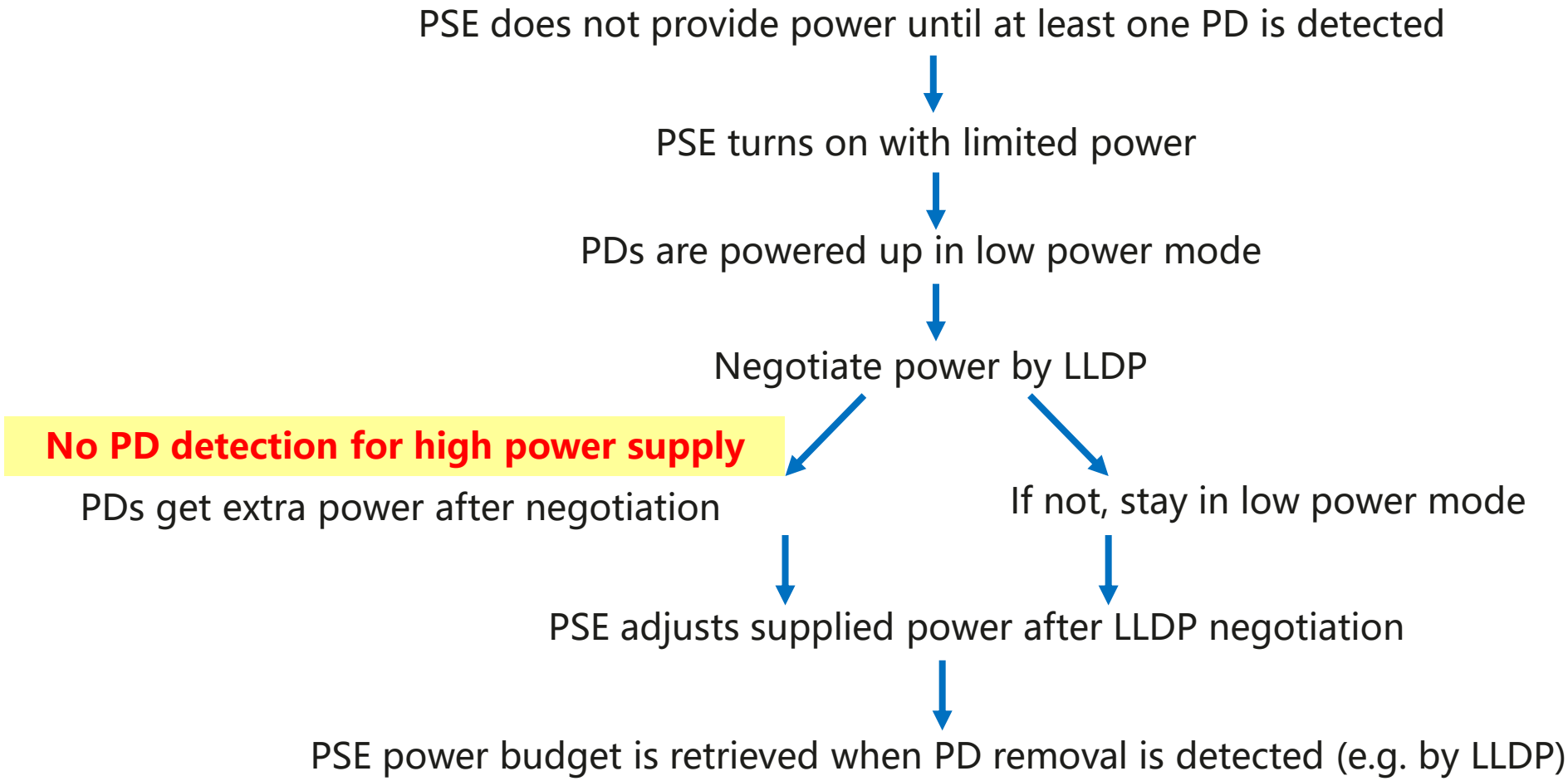
For single-pair PoE: PoDL

- PSE checks for a ~4V zener with a ~10mA test current for PD detection.
- After validated detection, PD classification is done using Serial Communication Classification Protocol (SCCP).

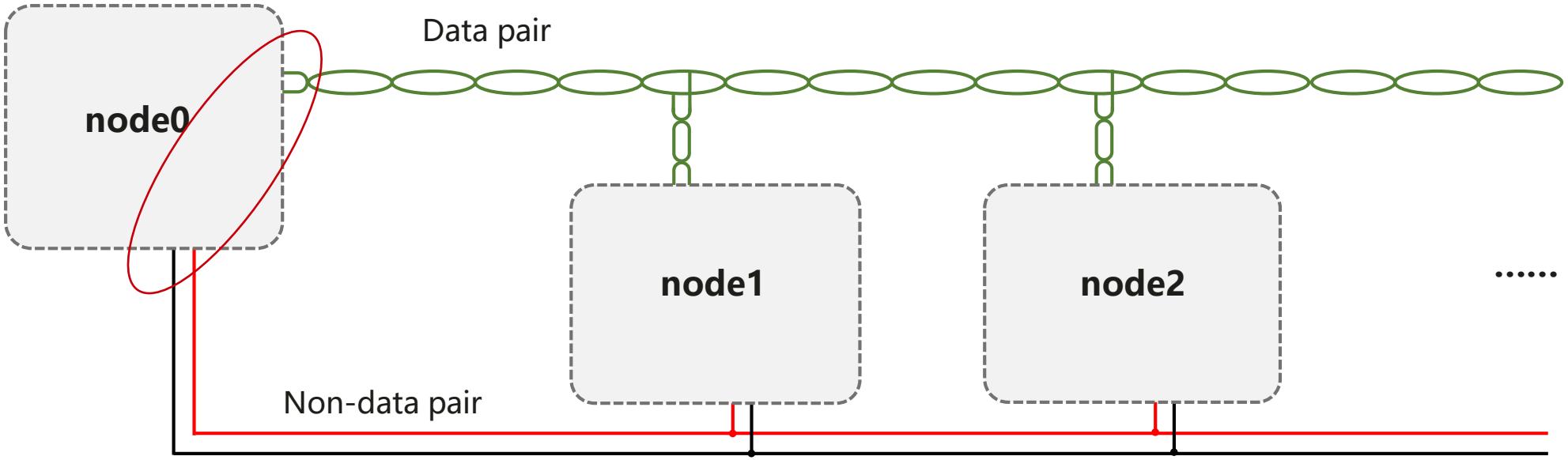
For SPMD:

- Can we **detect and classify PDs** by using the **classical voltage-current loop**?
- The difficulty is: all nodes share the medium, thus the returned current triggered by PSE detecting voltage from different PDs may be **mixed up**.

Previous discussion on multidrop powering procedure

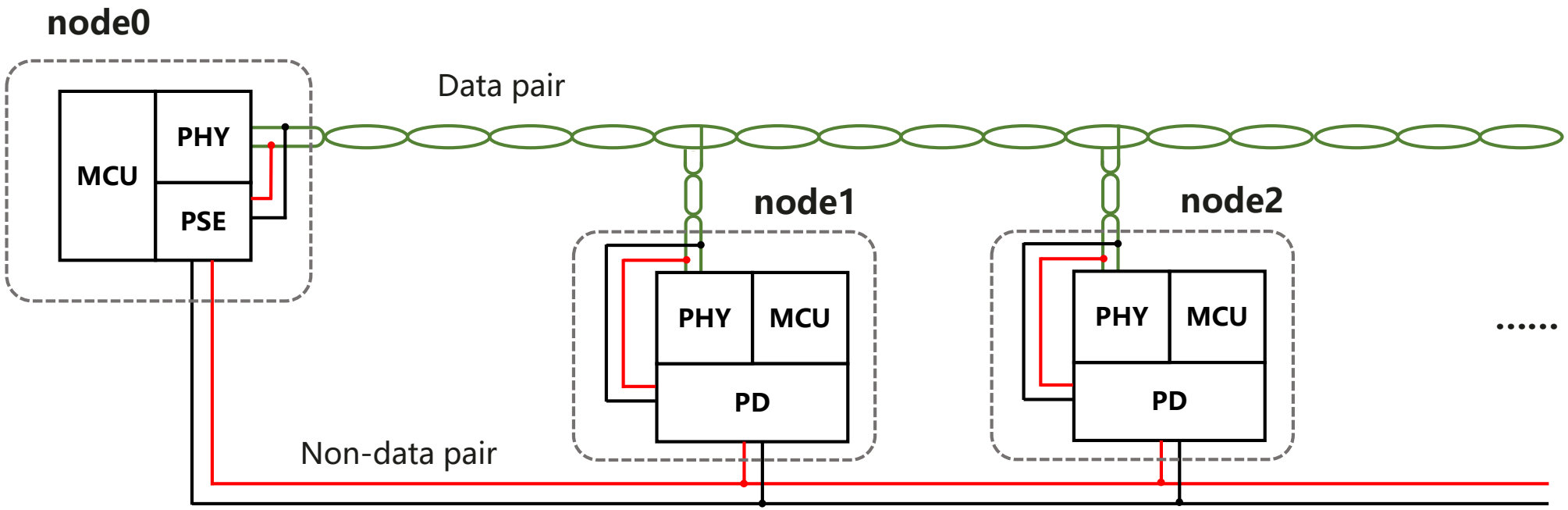


Assumptions of SPMD over both pairs



- Power over data power is only to power up the PHY and MCU w/o power management.
- Power management is for non-data pairs (extra power).
- Repeaters are not considered here.

SPMD power solution(1)



Key points:

~1W for each node

- PSE provides limited power for PHY and MCU through the **data-pair** (at least one PD is detected, then apply power);
- PHY and MCU is activated and work;
- Then, a polling-detection mechanism can be run to provide extra power over non-data pair:
  - Master (node with PSE) sends beacon over **data-pair** to start the detection cycle;
  - Paths of non-data pairs between the Master and all other nodes should be disconnected.
  - Then, a node transmits signal (e.g. predefined pattern) over the data-pair to claim its detection slot;
    -Transmit timeslot is determined by each node' s ID and counter (by PLCA mechanism)
  - Meanwhile, the **non-data pair** path between the node and the master is connected (which is controlled by its MCU through a simple switch).

PLCA

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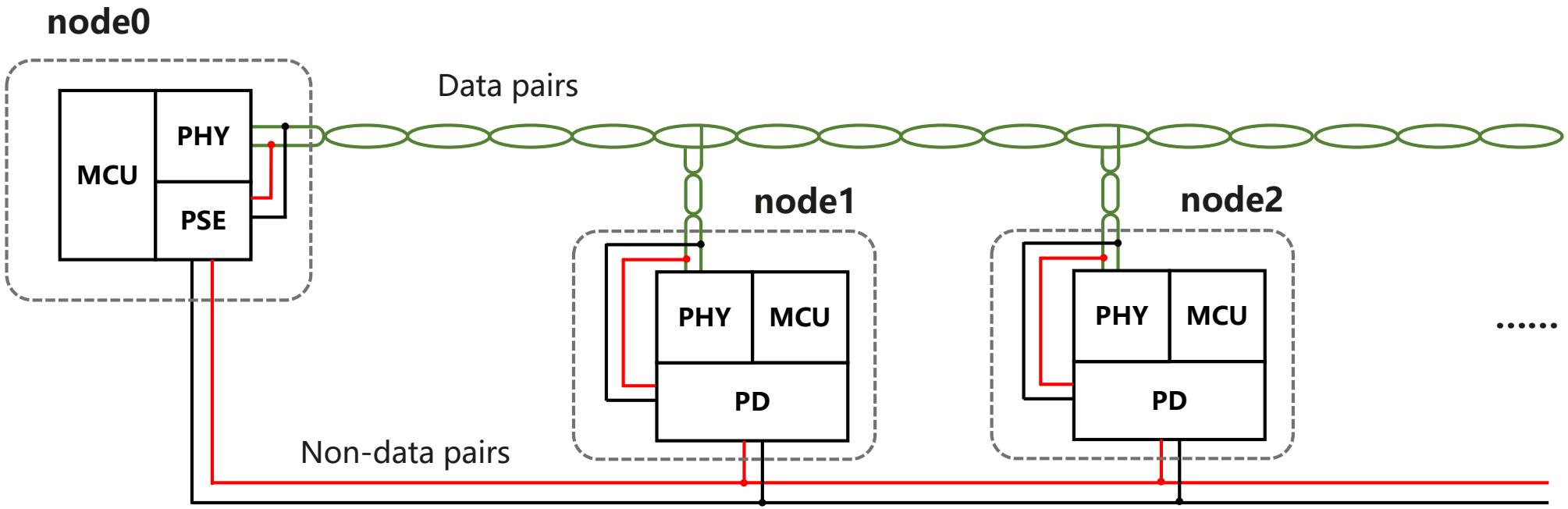
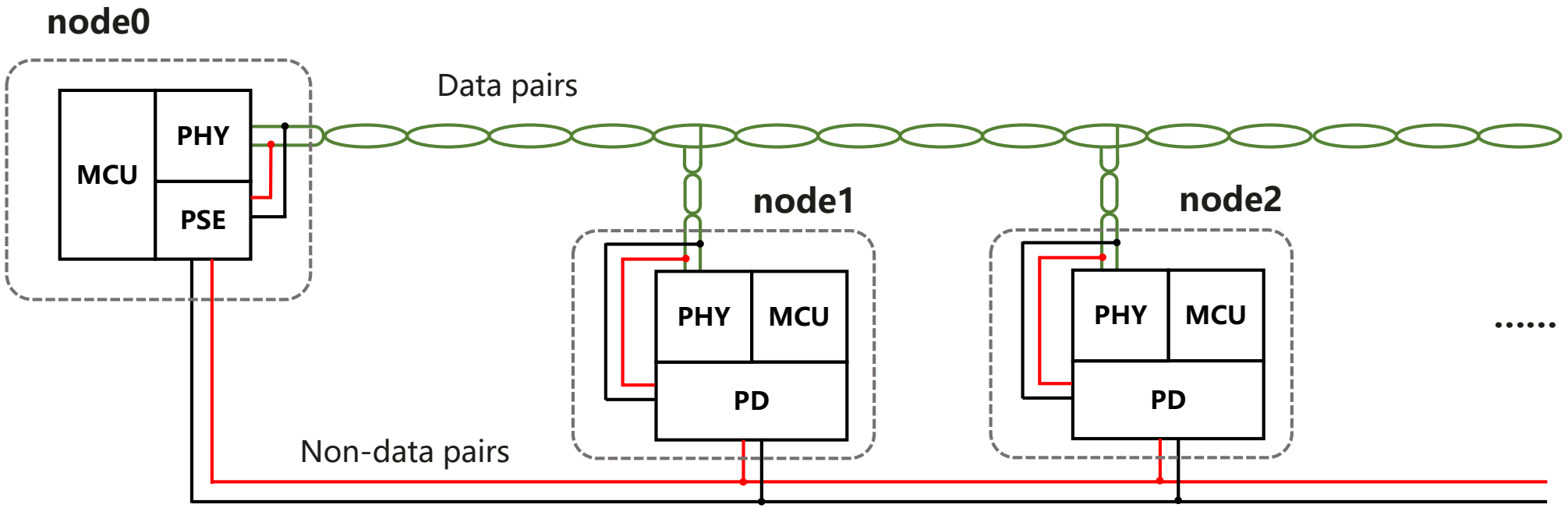
SPMD power solution(2)



Key points: (Cont.)

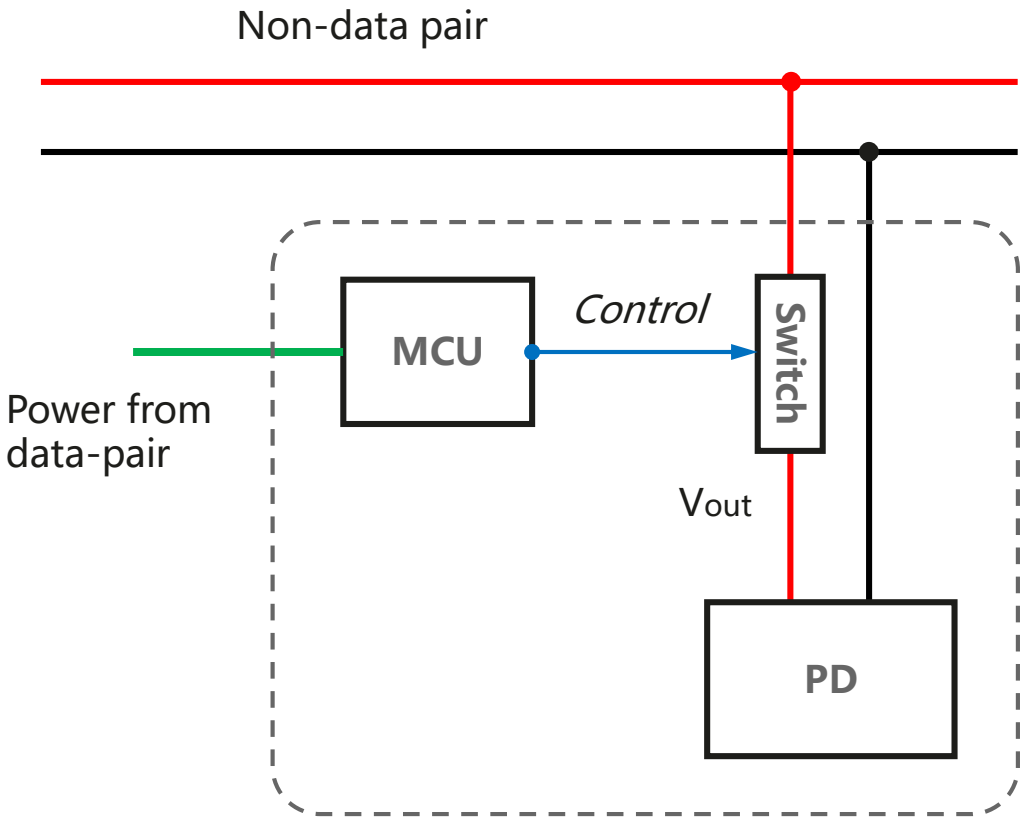
- In the detection slot, PSE sends detecting voltage through **non-data pairs** and receives response current from the connected PD.
- With this, PD detection can be done one-by-one through L1 method similar to what we have done before.
- Moreover, the PD classification can be done right after the detection or in another PLCA cycle.
- Alternatively, it can be just left to upper layer protocol (like LLDP)。

Some Benefits of this Layer 1 detection



- PSE is able to determine whether the connected node is a legal PD before applying higher power which might cause damage.
- With L1 detection design, we can provide short-circuit isolation instead of shut down the entire link when some PD is short.

Short-circuit PD isolation



With a switch in PD node:

- MCU controls the switch to connect power input to the PD load after passing detection & classification;
- If PD short-circuit occurs, the switch can be automatically disconnected based on Vout;
- The fault node can be isolated from other nodes being protected from shutting down;
  -The switch can be implemented by a MOSFET or triode
  -The short-circuit detecting & isolating circuit can be realized by simple analog components such as diode, triode…
- After short-circuit is fixed, MCU can connect the PD again (automatically or artificially) to the non-data pair.
  -MCU and PHY gets power from the separate data-pair

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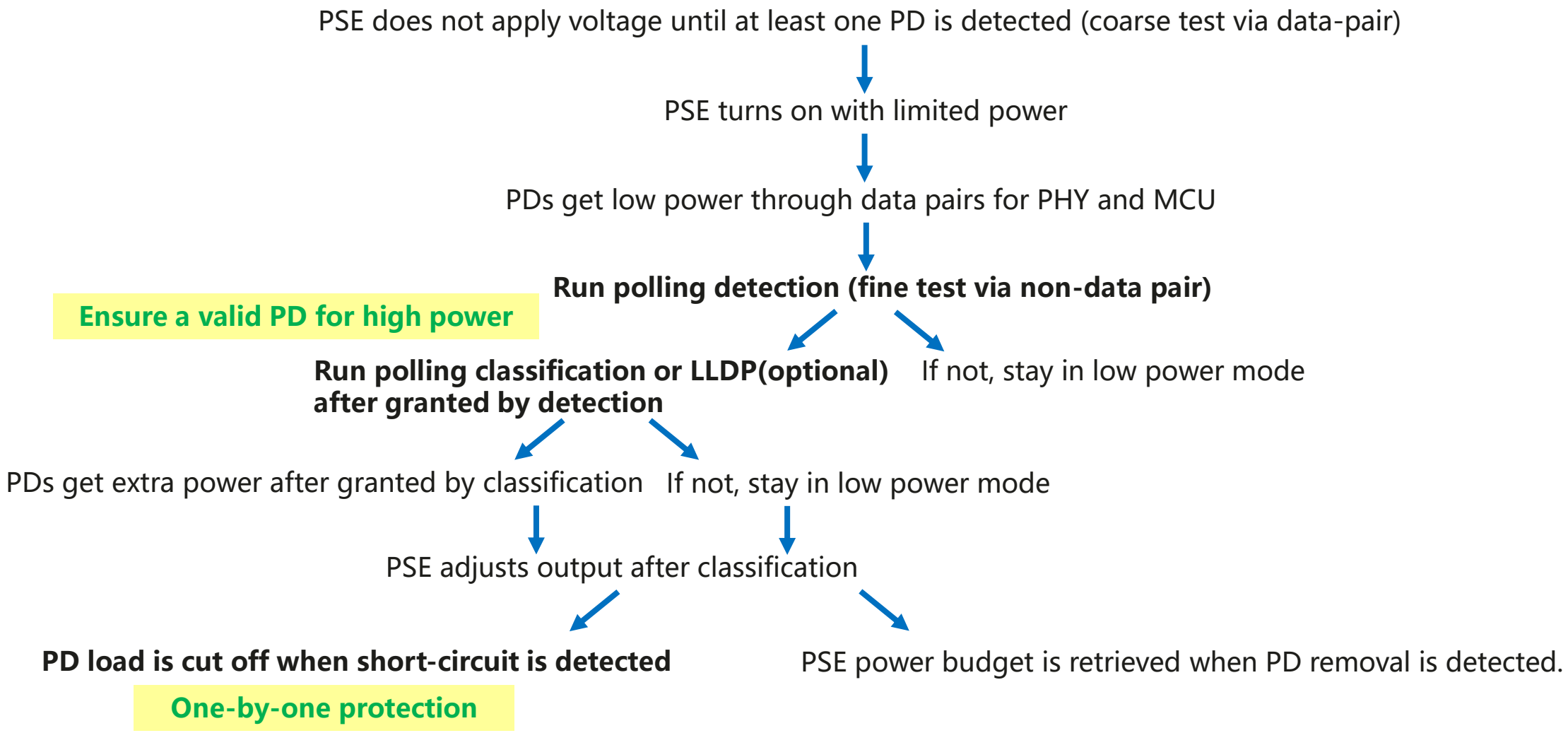
The updated multidrop powering procedure



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Summary

- A SPMD power solution over data-pair and non-data-pair is proposed for discussion.
- PHY and MCU on a node can get basic power from data pair.
- Node can get extra power from non-data pair.
- PD detection & classification (optional) can do one-by-one L1 detection with assistance of PLCA.
- Fault PD on non-data pair can be isolated to protect the entire system from shutting down

Thank you.

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