Trade-off Study of 4P PoE System Topologies

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Overview

- The classification adhoc committee can't complete its work until consensus is reached on the basic 4P topology.

- The issue is: Shall the PD have one or two detection/classification signatures?

- This decision is fundamental to the whole system design, so the Task Force has to make it, not the classification adhoc group.

- This presentation attempts to define and compare the two general categories of 4P topologies.
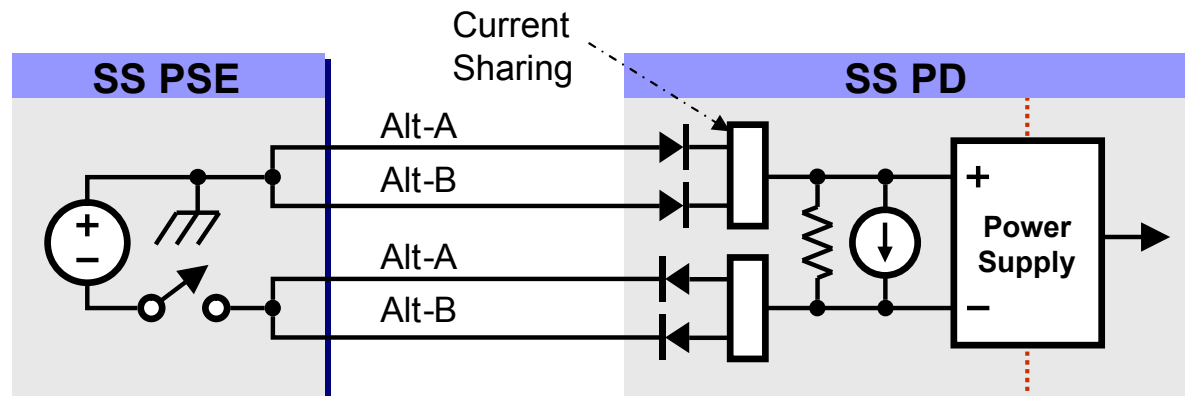
4P Topologies

- All possible 4P system topologies can be categorized as either *Single Signature* (SS) or *Dual Signature* (DS). (See the diagrams on the next slide.)

- In a SS system, the PSE looks for a single PD detection/classification signature.

- In a DS system, the PSE looks for two PD detection/classification signatures.

- Therefore SS and DS systems are generally incompatible.

4P Topologies Continued

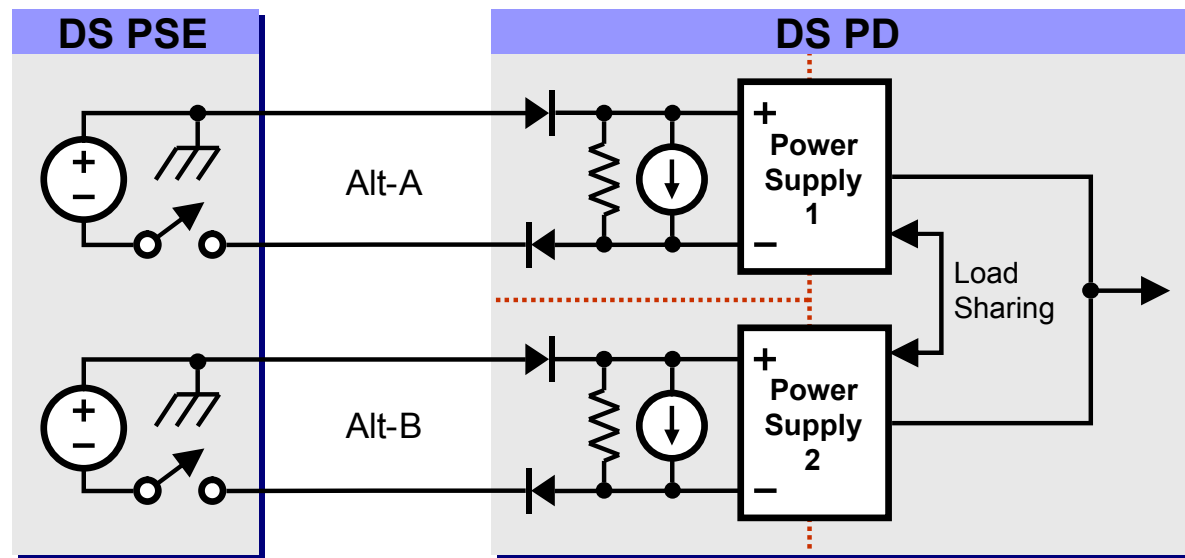Example of
Single Signature
Topology

Current Sharing: Needed
only for high-power PD.

Example of
Dual Signature
Topology

Symbol Legend

- ↓ = L1 Class Signature
- ⌇ = Detection Signature
- ⌒o = Pwr Ctrl/Curr Limit
- ····· = Isolation Barrier

The Goal of This Presentation

- **Variations exist in both SS and DS topologies.**
  - □ The goal in this presentation is *not* to try to work out the best variation for either topology.

- **Instead, the goals are:**
  - □ To identify the inherent advantages/disadvantages of both topologies.
  - □ To examine the practicality of some possible solutions to the biggest problems.
  - □ To provide the Task Force with information to help make the decision between SS and DS.

Dual Signature Topology

Advantages and Disadvantages

- **Advantages**
  - Users might be able to power PDs up to 26W without replacing existing PSE HW, by using a 802.3af endspan and midspan in conjunction.
  - Dual sources can provide redundancy for high-availability systems.
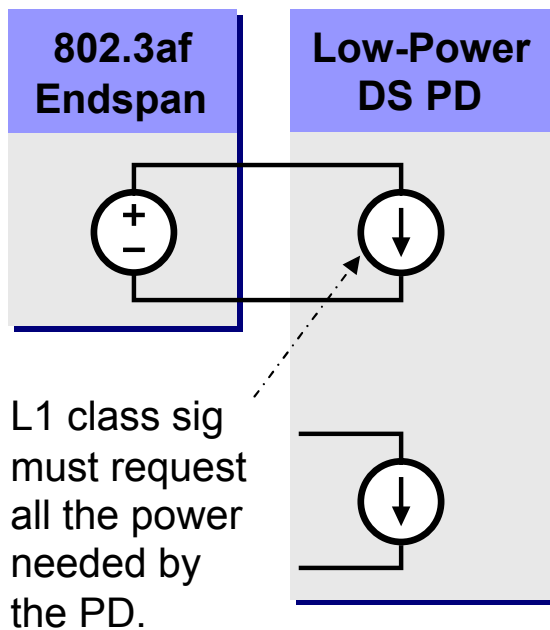
- **Disadvantages**
  - The PD is more complex and expensive.
  - Test equipment costs more. (See pages 18 and 19.)
  - Power management issues. (See next several slides.)

Dual Signature Topology

Power Management Issues

Problem 1: For L1 classification, how would the DS PD request only the power that it needs in all cases?

Case 1

802.3af Endspan

Low-Power DS PD

L1 class sig must request all the power needed by the PD.

Case 2

L1 class sig must request all the power needed by the PD.

Low-Power DS PD

802.3af Midspan

Case 3

DS PSE
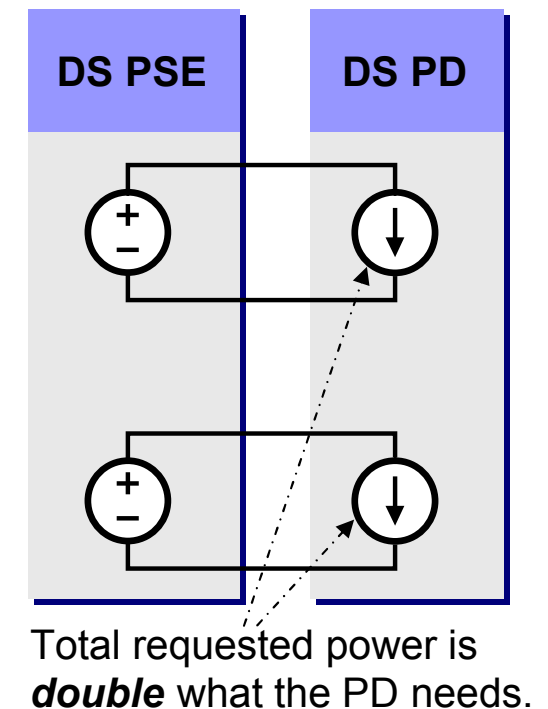
DS PD

Total requested power is *double* what the PD needs.
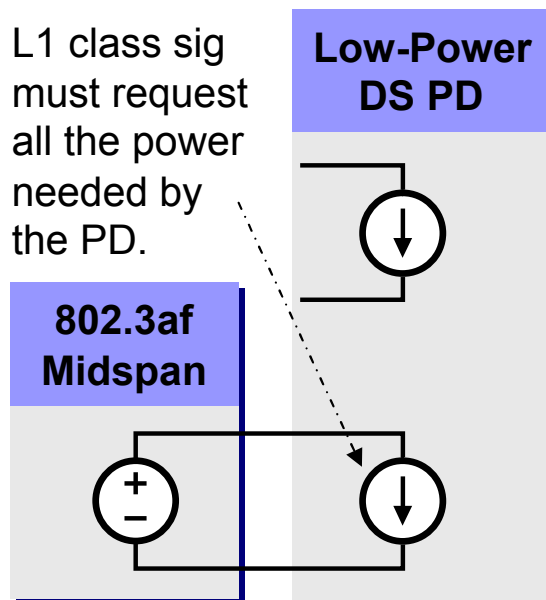
Dual Signature Topology

Power Management Issues (continued)

- **1st Possible Solution: Outlaw cases 1 and 2.**
  - ☐ DS would be used for PDs that require >13W.
  - ☐ SS would be used for PDs that require <13W.
  - ☐ Each side of DS PD requests 50% of required power.
- **Issues with this solution:**
  - ☐ SS PDs can't be reworked to be DS, or vise versa. This represents a big risk for PD designs near 13W.
  - ☐ Forcing low-power PDs to use 2P would be an unnecessary waist of power.
  - ☐ Some low-power PDs might need 4P for the sake of redundancy rather than efficiency.

Dual Signature Topology
Power Management Issues (continued)

- **2nd Possible Solution: A smarter DS PSE**
  - ☐ Each side of DS PD requests 100% of the needed power.
  - ☐ If the DS PSE sees two identical classification signatures, then it allocates only 50% the total requested power (case 3).
  - ☐ If the DS PSE sees only one classification signature, then it allocates all the requested power (case 4).

Case 3

DS PSE	DS PD

Case 4

DS PSE	802.3af PD
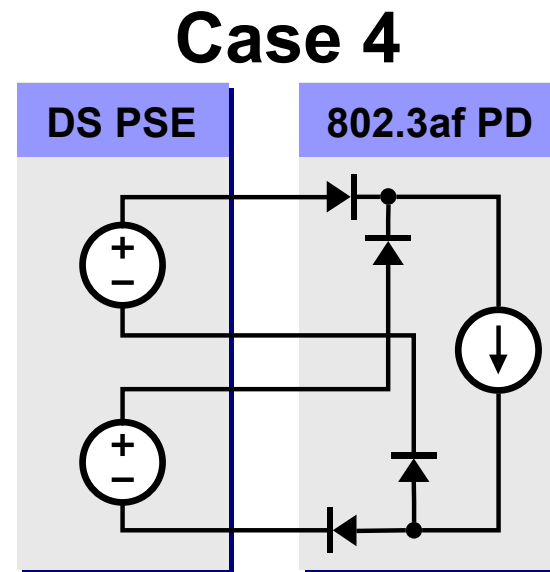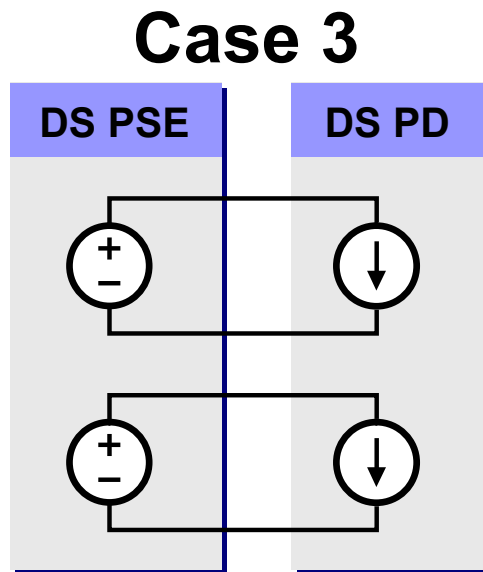
Dual Signature Topology
Power Management Issues (continued)

- **Issues with 2nd solution:**
  - Doesn't work with case 5 because we can't make legacy PSEs smarter.
  - Doesn't work with case 6 because each PD gets only half its requested power.

Case 5

802.3af Endspan	802.3af Midspan	DS PD

Case 6

DS PSE	2P PD

2 PDs on <u>one</u> cable. These PDs could be 802.3af or medium-power 2P (802.3at).
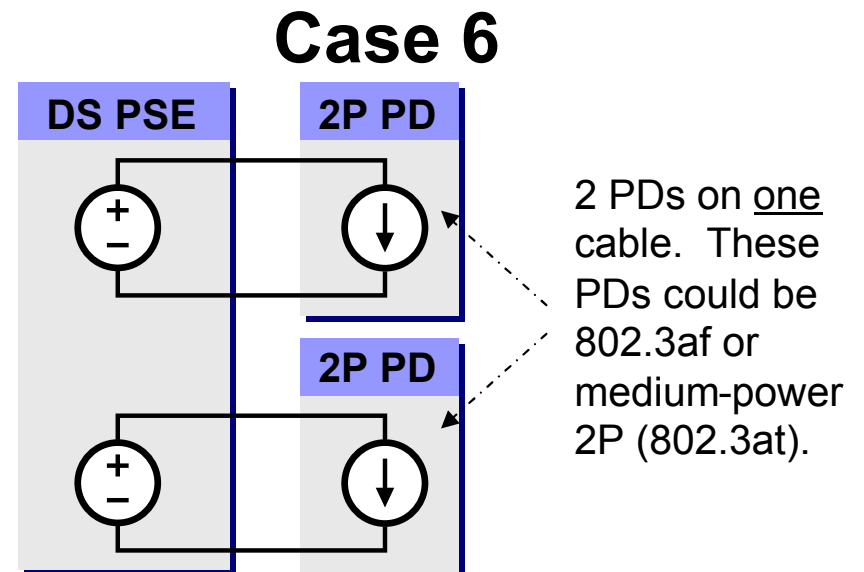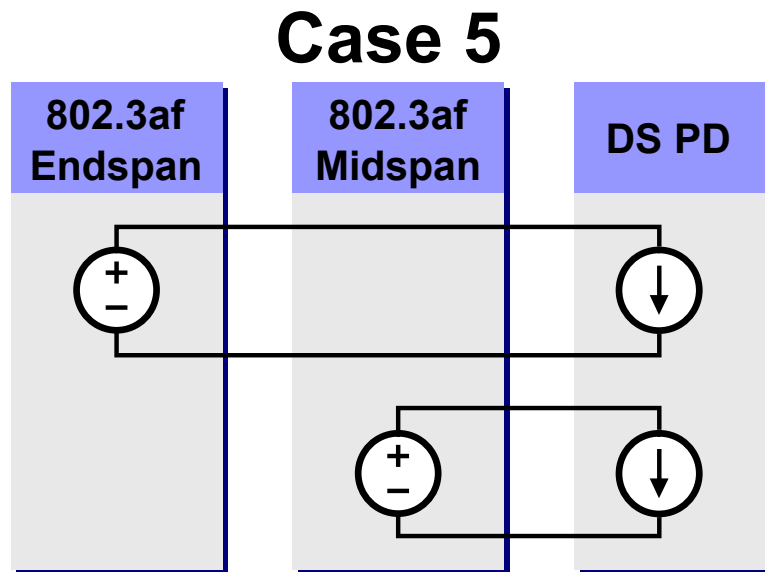
Dual Signature Topology
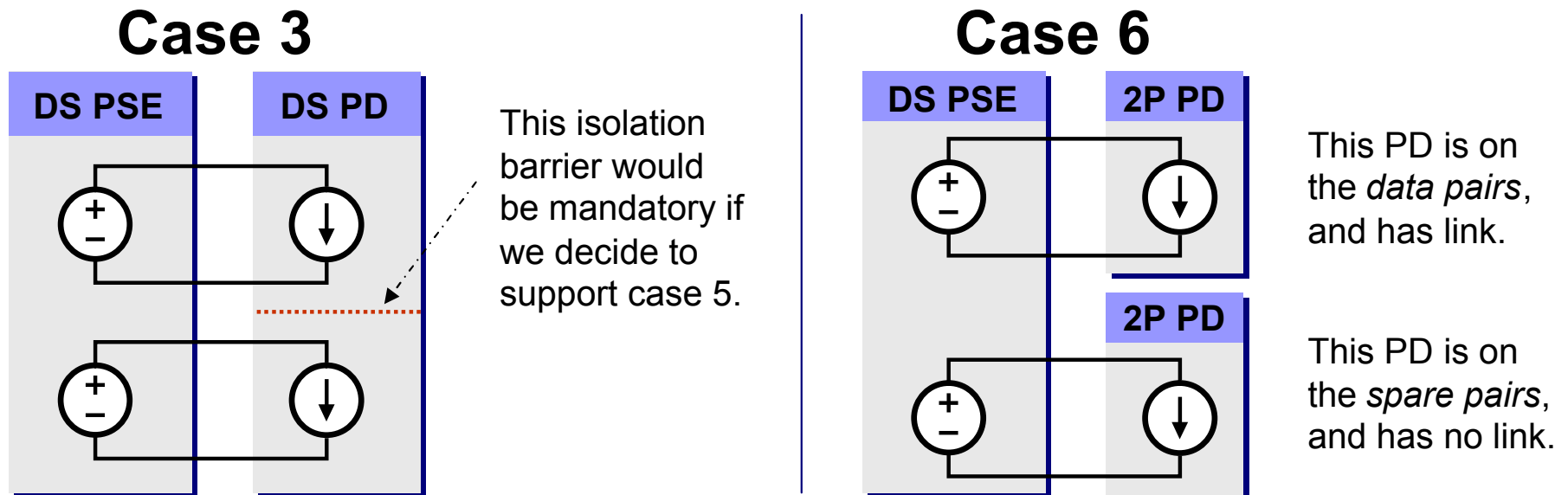
Power Management Issues (continued)

- 3rd Possible Solution: A smarter DS PD.
  - The DS PD would have to start with *invalid* detection signatures on both sides. This holds off classification until the PD can determine if the PSE can power both sides or only one.
  - The PD must wait in this state for a TBD time period. Then:
    - If the PSE can power both sides, the DS PD sets its class signature on each side to request 50% of the total required power.
    - If the PSE can only power one side, the DS PD sets its class signature on that side to request 100% of the required power.
  - Then the DS PD sets valid detection signatures on both sides.

- Issues with 3rd solution:
  - Obviously this is pretty complex, and probably expensive.
  - PD must do all this using the detection waveform for power.
  - Could significantly slow down the power-up sequence.

Dual Signature Topology
Power Management Issues (continued)

Problem 2: There is no way for a DS PSE to distinguish between cases 3 and 6 with a L1 protocol. (Can't do it with L2 either because PD on spare pairs has no link.)

I have no solutions for this problem.

Case 3

DS PSE · DS PD

This isolation barrier would be mandatory if we decide to support case 5.

Case 6

DS PSE · 2P PD

This PD is on the *data pairs*, and has link.

2P PD

This PD is on the *spare pairs*, and has no link.

Single Signature Topology

Advantages and Disadvantages

- **Advantages**
  - ☐ SS PD is simpler and less expensive.
  - ☐ No inherent power management issues.
  - ☐ Test equipment is cheaper.

- **Disadvantages**
  - ☐ Can't support cases 5 or 6.
  - ☐ Might need Active Current Sharing (ACS) circuitry.
    - High-power PDs might include ACS circuits.
    - Low-power 4P PDs would not.
    - PSE cost is unaffected

Do We Really Need Case 6?

- **Do we need case 6?**
  - It's not included in the official Task Force objectives.
  - No known applications require two PDs on the same cable.

- **Is case 6 even practical?**
  - DS PSE can't tell the difference between cases 3 and 6. How can we do power management if we don't even know how many PDs are on the line?
  - Can't do L2 protocol in case 6 because one PD is connected on the spare pairs and has no link.

Do We Really Need Case 5?

- If you already own an Af-endspan and you want to run higher power PDs, you have two choices:
  - ☐ Add an Af-midspan to augment the Af-endspan (case 5).
  - ☐ Add an At-midspan (case 5a).
- The At-midspan will be more expensive. But is the cost difference significant enough to justify all the issues associated with DS?

Case 5		
802.3af Endspan	**802.3af Midspan**	**DS PD**

Case 5a		
802.3af Endspan	**802.3at Midspan**	**DS PD**
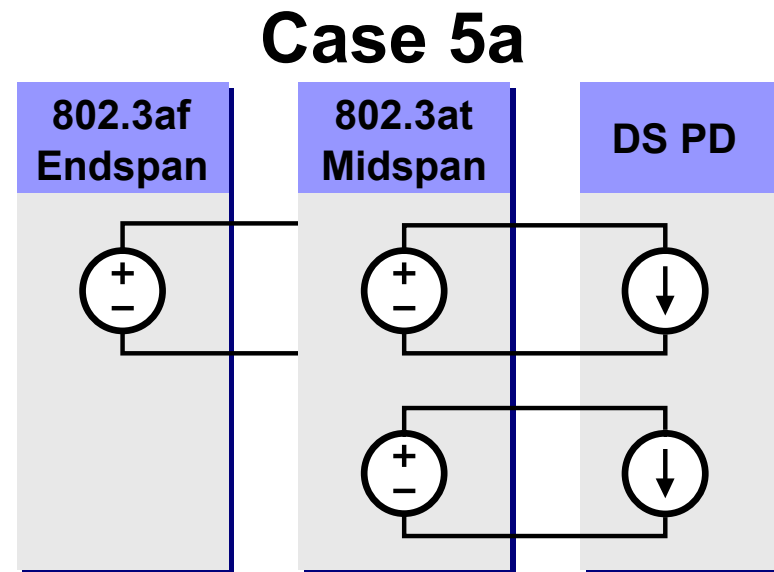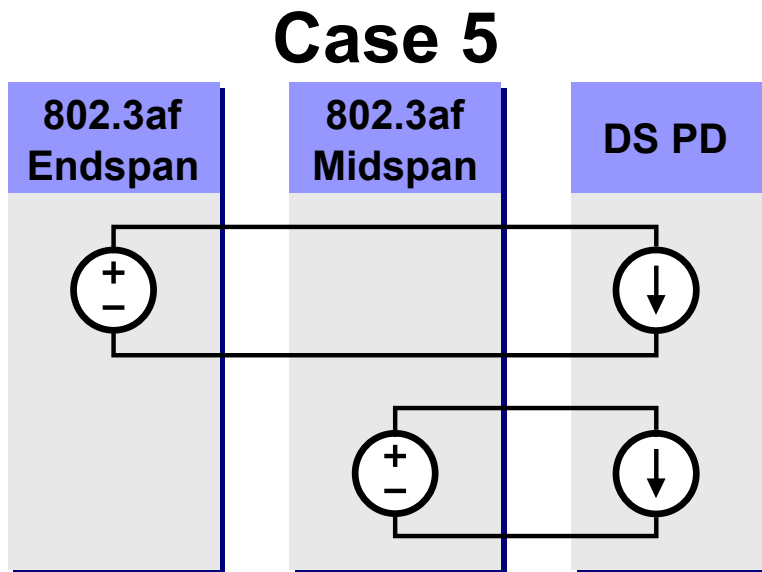
Is Case 5 Even Practical?

- The Task Force agreed to not rule out "medium" power on 2P for 802.3at PSE.

- Consider case 5b where an Af-endspan is used in conjunction with an At-midspan.

- How would this work?

  - To get the most power, the PD would have to present different class signatures to the two PSEs.

- Perhaps 802.3at midspans should <u>always</u> be 4P.

Case 5b

| 802.3af Endspan	802.3at Midspan	DS PD
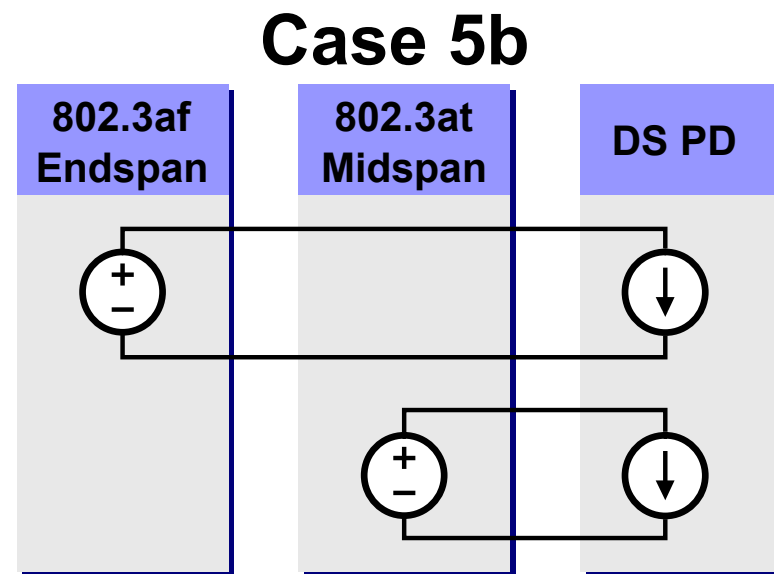
Notes on Redundancy

- Redundancy is not included in the official objectives of the 802.3at Task Force.

- No known PD applications require it.

- Difference between DS and SS:
  - DS offers full redundancy; main power supply and port circuitry.
  - SS offers redundancy of main power supply only. (Some 802.3af PSE already have redundant PS.)

- The cabling will probably be the limiting factor on system reliability, not the port circuitry.
  - Therefore the reliability of DS and SS systems are probably about the same.

802.3at PSE Test Setups

- PSE manufacturers have two options:
  - ☐ Reuse existing 802.3af test equipment for 802.3at.
  - ☐ Buy new test equipment designed specifically for 802.3at.
- Obviously reusing old testers would be cheaper and faster. But there are at least two reasons why 802.3af testers may not work for 802.3at:
  - ☐ New L1 extended classification protocol.
    - Probably not a problem for COTS testers from Ixia or Sifos. (Just a software update?)
    - For custom in-house testers, ask your test engineers.
  - ☐ Higher power levels.
    - If your test plan calls for max load (>30W) on all ports concurrently, then you probably need new testers.
    - If 20W to 30W per port is acceptable, then you can probably reuse the old testers.

Reusing Old PSE Testers

- **Original 802.3af Test Setup:**
  - A lot of testers designed for 802.3af PSE are out there.
  - Replacing them all would be a very large expense.

802.3af PSE	802.3af PSE Tester
Port 1 ———————	Port 1
Port 2 ———————	Port 2
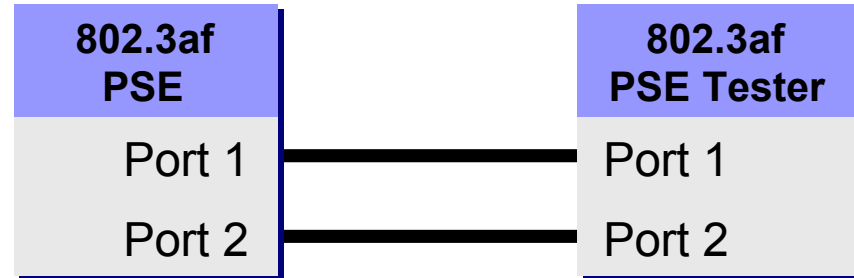
- **Tester reused for DS PSE:**
  - Y-cables replace CAT-5/6.
  - Doubles testers power/port.
  - But 50% fewer tester ports.

802.3at DS PSE	802.3af PSE Tester
Port 1 ——— Data Pairs	Port 1
Port 2 — ? Spare Pairs	Port 2
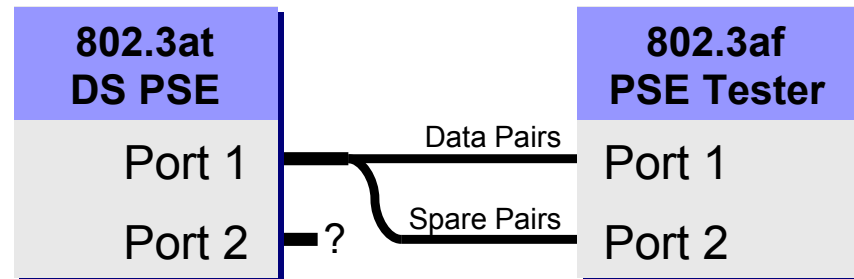
- **Tester reused for SS PSE:**
  - No setup changes needed.
  - Same number of tester ports.
  - But power/port still limited to 802.3af levels.

802.3at SS PSE	802.3af PSE Tester
Port 1 ———————	Port 1
Port 2 ———————	Port 2

Summary

- The classification adhoc committee can't complete its work until a decision is reached by the Task Force, selecting either the SS or DS topology.
- The Task Force needs to decide if cases 5 and/or 6 must be supported.
  - ☐ If so, then DS is mandatory, the PD must have isolation between its inputs, and we need to find better solutions for the power management issues.
  - ☐ If not, then SS seems to be the best topology based on cost, complexity, and power management.
- DS has at least 2 power management issues that don't seem to have any good solutions.
- The cost impact on test equipment should be a factor in the decision.