

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.

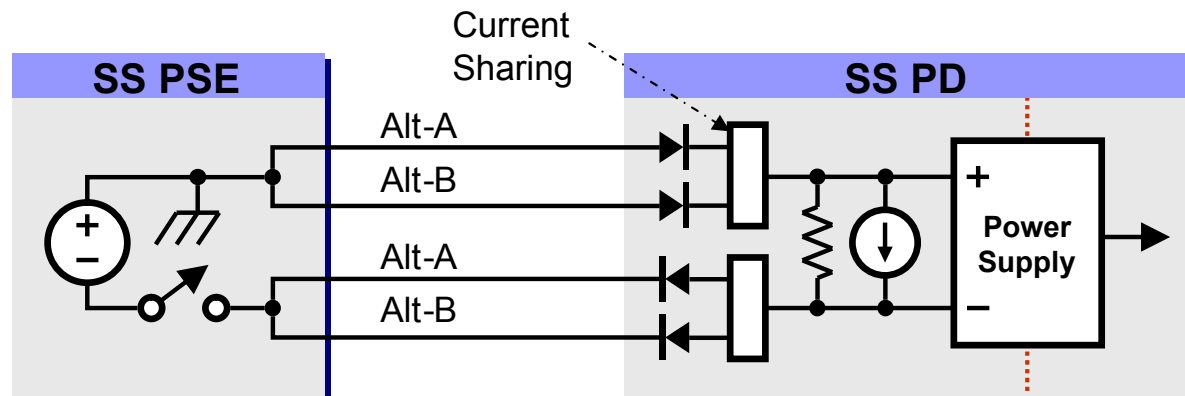
4P Topologies

- 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

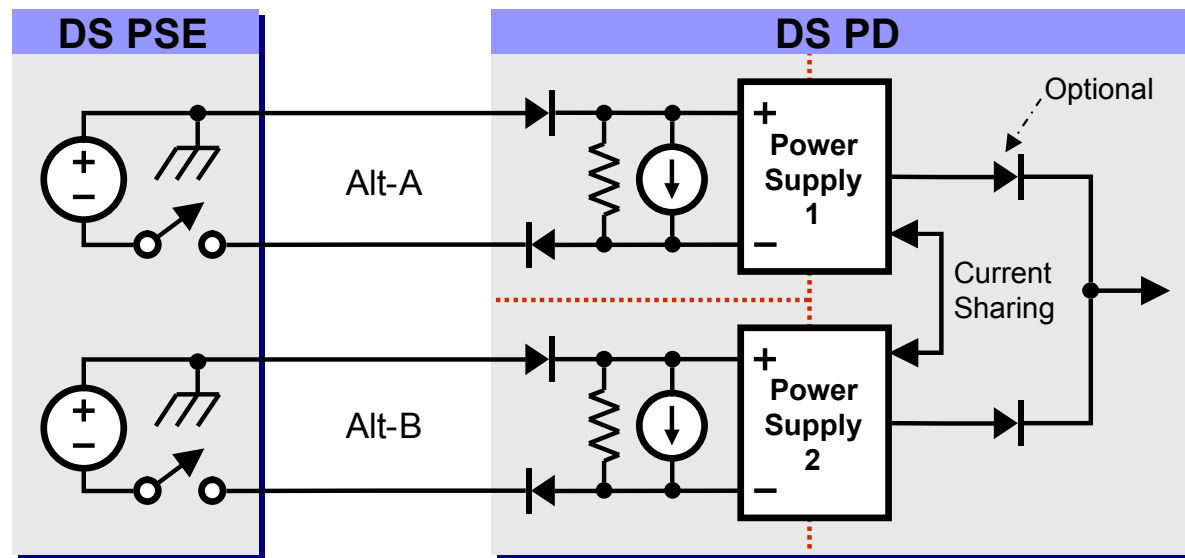
Current Sharing: Needed only for high-power PD.



Example of Dual Signature Topology

Symbol Legend

- = L1 Class Signature
- = Detection Signature
- = 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

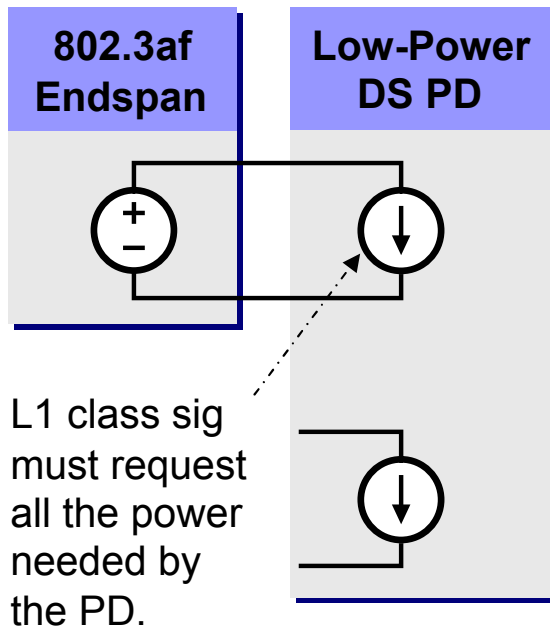
- The PD is more complex and expensive.
- Test equipment costs more. (See pages 18 and 19.)
- Power management issues. (See next several slides.)

Dual Signature Topology

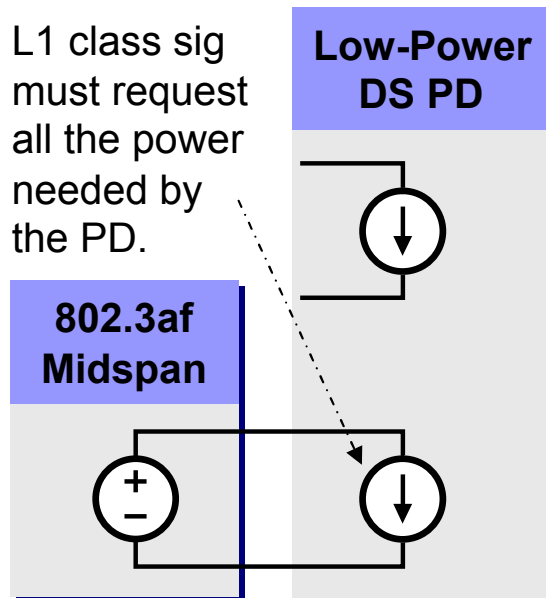
Power Management Issues

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

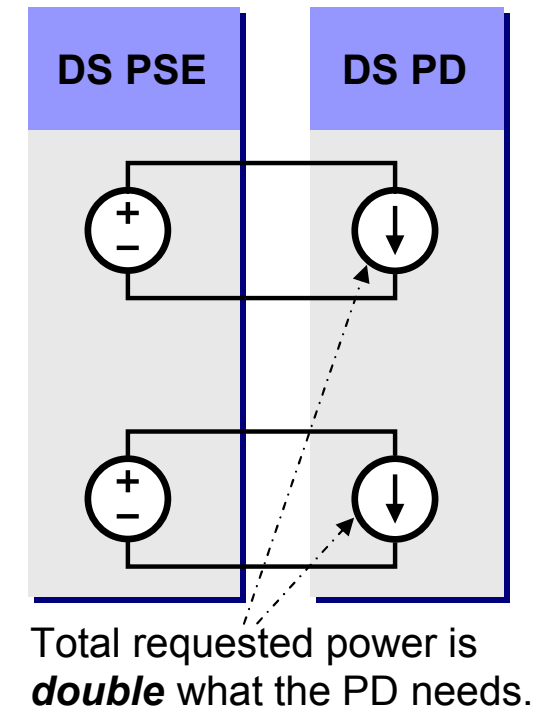
Case 1



Case 2



Case 3



Dual Signature Topology

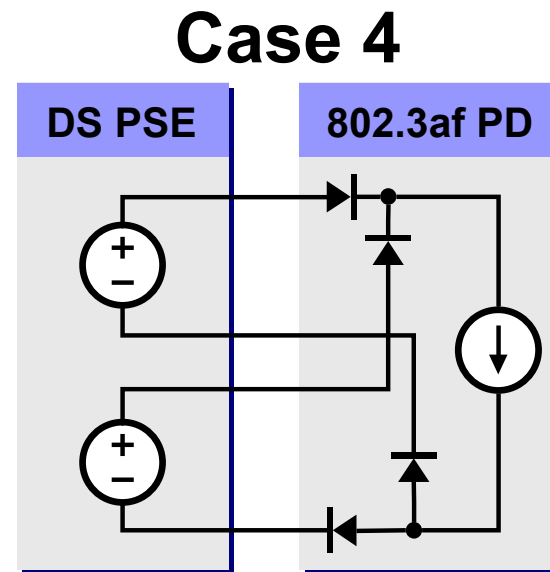
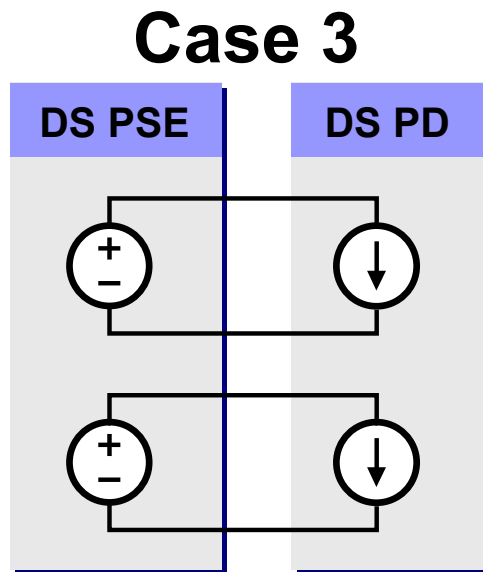
Power Management Issues (continued)

- 1st Possible Solution: Outlaw cases 1 and 2.
 - DS would be used for PDs that require $>13\text{W}$.
 - SS would be used for PDs that require $<13\text{W}$.
 - Each side of DS PD requests 50% of required power.
- Issues with this solution:
 - SS PDs can't be reworked to be DS, or vice 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).

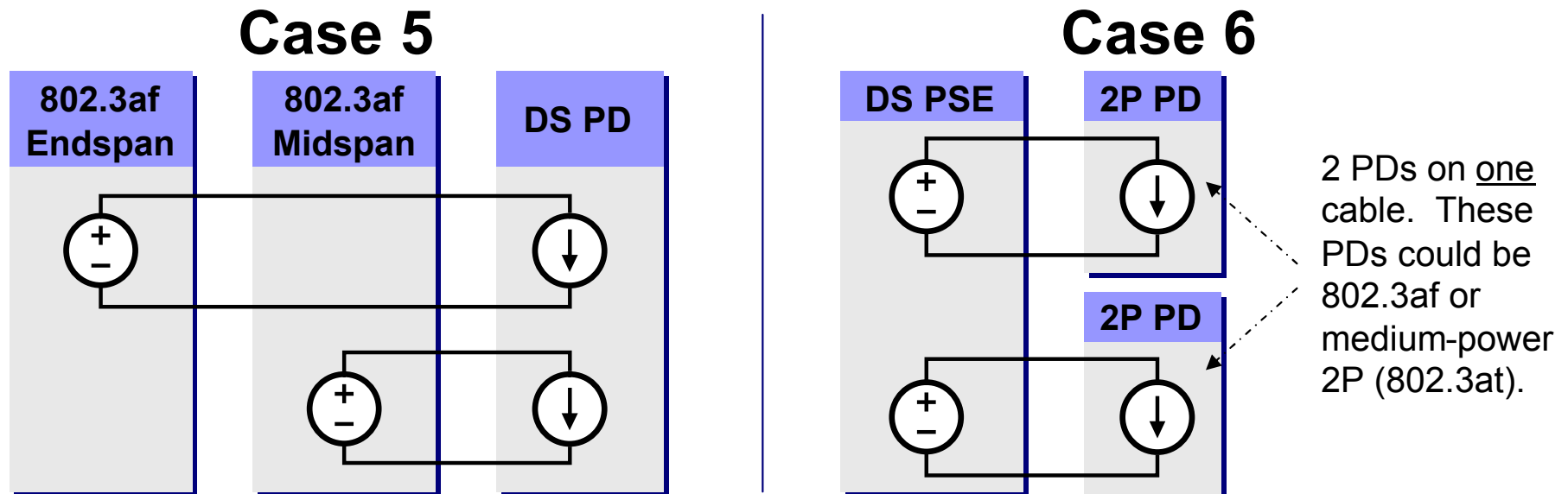


Dual Signature Topology

Power Management Issues (continued)

■ Issues with 2nd solution:

- Doesn't work with case 5 because we can't make legacy PSEs smarter. Allocated power is 200% of needed power.
- Doesn't work with case 6 because each PD gets only 50% of the power it needs.



Dual Signature Topology

Power Management Issues (continued)

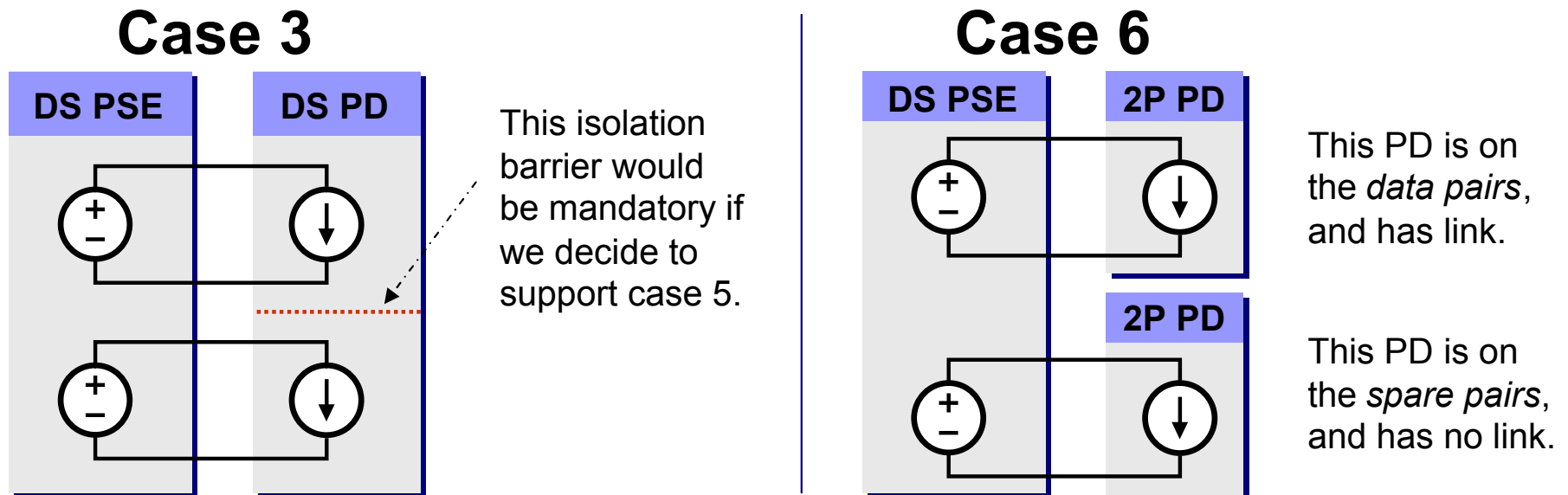
- 3rd Possible Solution: A smarter DS PD.
 - The DS PD would have to start with *invalid* detection signatures on both sides. This holds off classification until the PD can determine if the PSE can power both sides or only one.
 - The PD must wait in this state for a TBD time period. Then:
 - If the 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.
 - Will 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.



Single Signature Topology

Advantages and Disadvantages

■ Advantages

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

■ Disadvantages

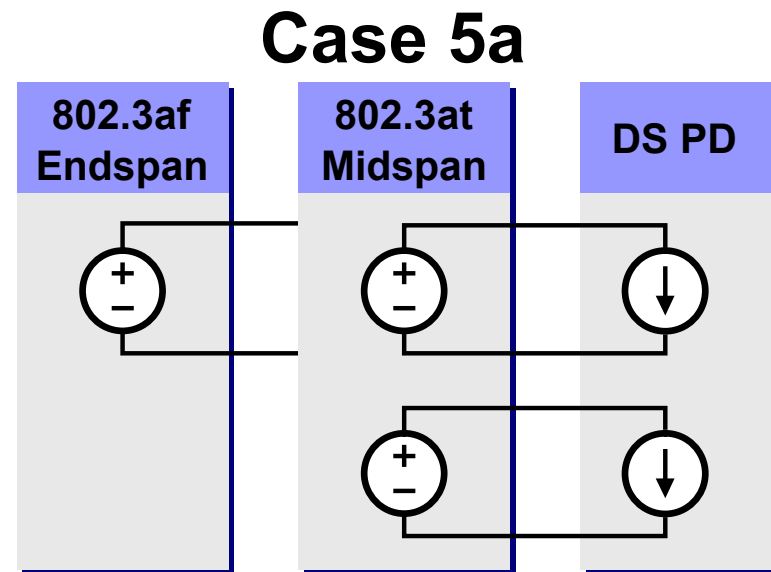
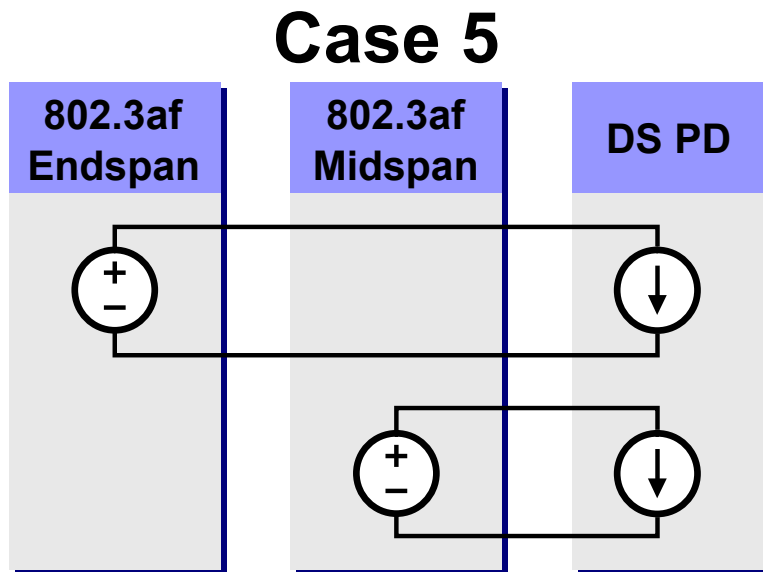
- Can't support cases 5 or 6.
- Might need Active Current Sharing (ACS) circuitry.
 - High-power PDs might include ACS circuits.
 - Low-power 4P PDs would not.
 - PSE cost is unaffected

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 running off one PSE port.
- 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 any port?
 - Can't do L2 protocol in case 6 because one PD is connected on the spare pairs and has no link.

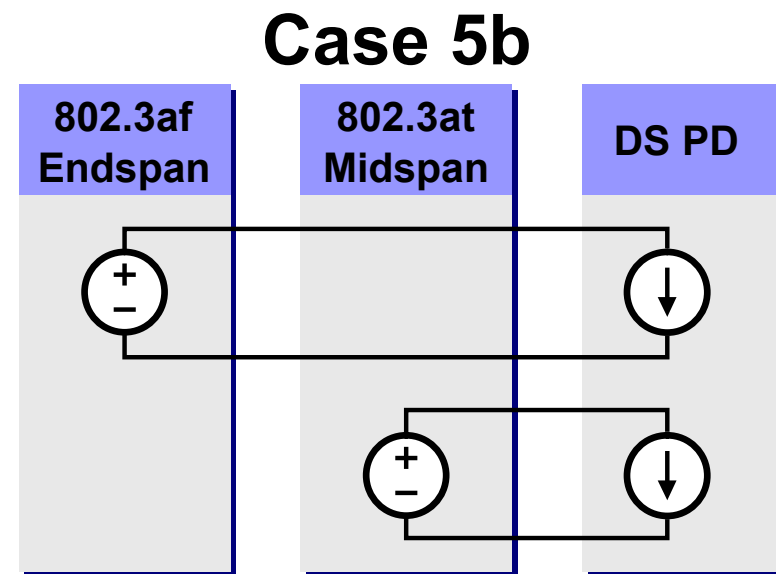
Do We Really Need Case 5?

- 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?



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?
 - Power management software has to work with Af and At PSEs together.
 - Do the two PSEs share the load equally?
- Perhaps 802.3at midspans should always be 4P. (Or at least use 4 transformers.)



Notes on Redundancy

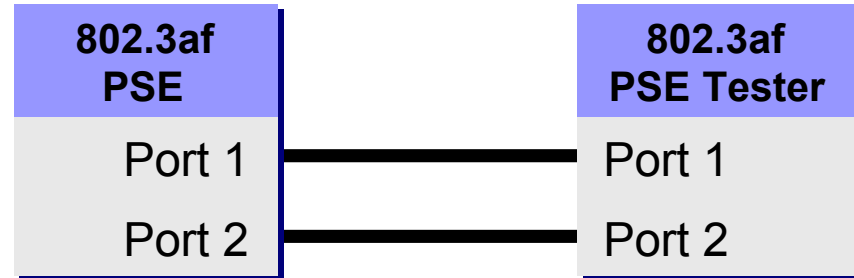
- Redundancy is not included in the official objectives of the 802.3at Task Force.
- No known PD applications require it.
- Difference between DS and SS:
 - DS: Fully redundant. Power supplies and PSE port circuitry.
 - SS: Partial redundant. Everything except PSE port circuitry.
 - You can have redundant PS in the PSE and PD if you want.
- Will redundancy really improve reliability? It depends:
 - Are the power supplies in the PD specifically designed for redundant operation? If not (likely often the case) then dual supplies will actually decrease reliability instead of increasing it.
 - Reliability of wiring must also be considered.
- So which is more reliable, DS or SS? It's a toss up.

802.3at PSE Test Setups

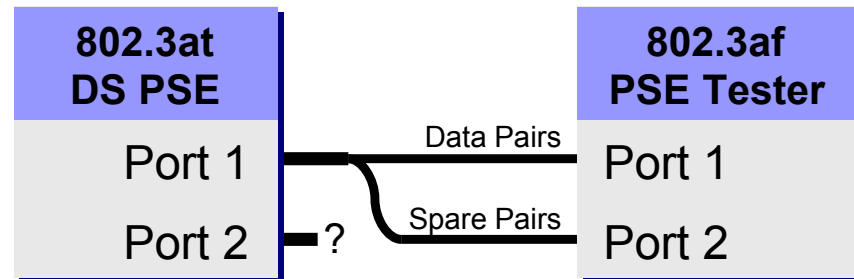
- PSE manufacturers have two options:
 - Reuse existing 802.3af test equipment for 802.3at.
 - Buy new test equipment designed specifically for 802.3at.
- Obviously reusing old testers would be cheaper and faster. But there are at least two reasons why 802.3af testers may not work for 802.3at:
 - New 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.



- Tester reused for DS PSE:
 - Y-cables replace CAT-5/6.
 - Doubles testers power/port.
 - But 50% fewer tester ports.



- Tester reused for SS PSE:
 - No setup changes needed.
 - Same number of tester ports.
 - But power/port still limited to 802.3af levels.



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.