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 a single classification signature, or two?
- This decision is fundamental to the whole system design, so the Task Force has to make it, not the classification adhoc.
- This presentation attempts to define and compare the two general categories of 4P topologies.

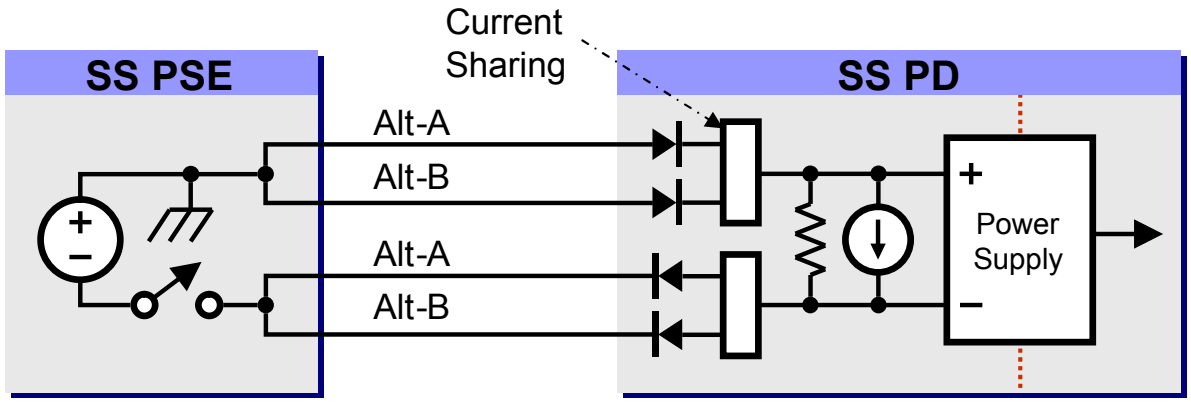
4P Topologies

- 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

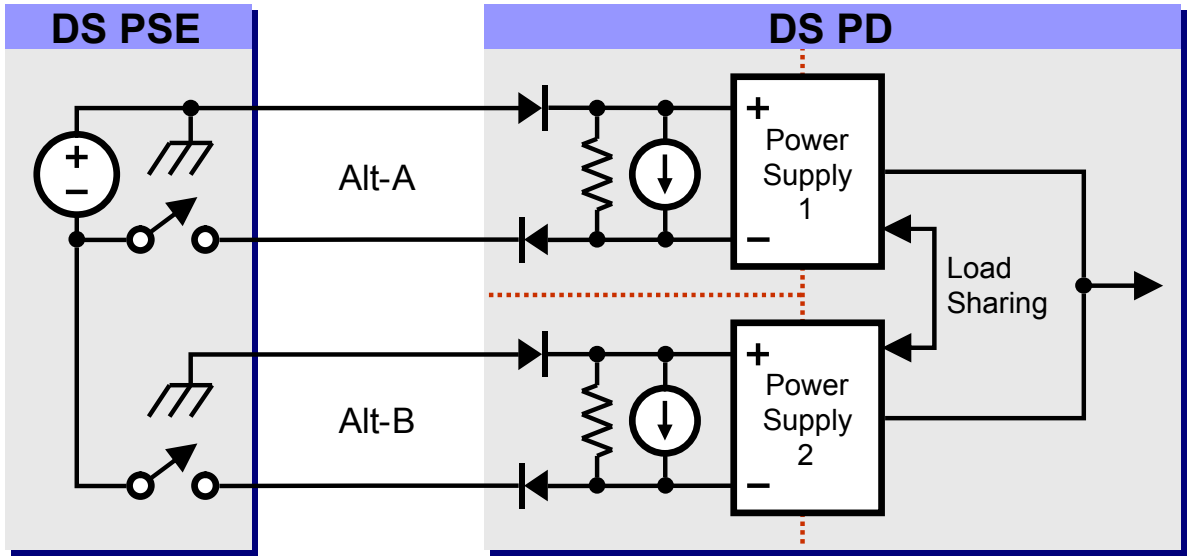
Symbol Legend

= 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.
  - To examine the practicality of some possible solutions to the biggest problems.
    - I don't claim to have the *only* solutions.
    - I don't claim that *better* solutions are impossible.
    - But I do claim that I tried my best to find practical solutions.
  - To provide the Task Force with information to help make the decision between SS and DS.

Dual Signature Topology

Advantages and Disadvantages

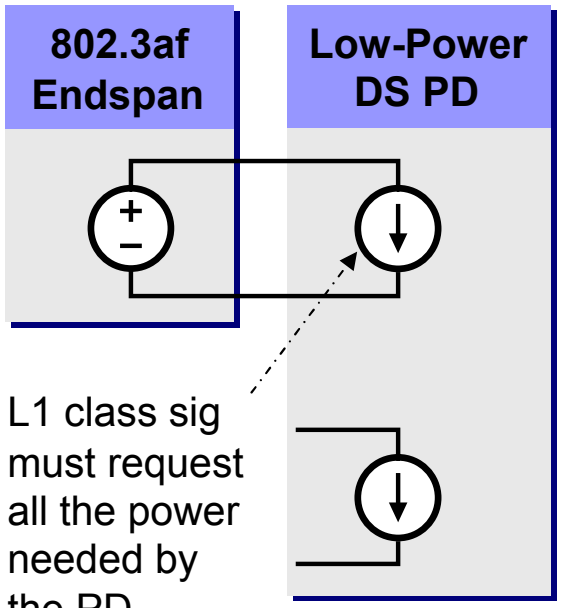
- Advantages
  - Users might be able to power PDs up to 26W without replacing existing PSE HW, by using a 802.3af endspan and midspan in conjunction.
  - Dual sources can provide redundancy for high-availability systems (possible examples: medical monitors, alarm systems).
  - Current sharing is inherent, assuming PD has isolation between inputs. (Isolation would be necessary for both bullets above.)
- Disadvantages
  - The PD is more complex and expensive.
  - The test equipment is more complex and expensive.
    - Existing testers would probably have to be replaced.
  - Some power management issues (see next several slides).

Dual Signature Topology

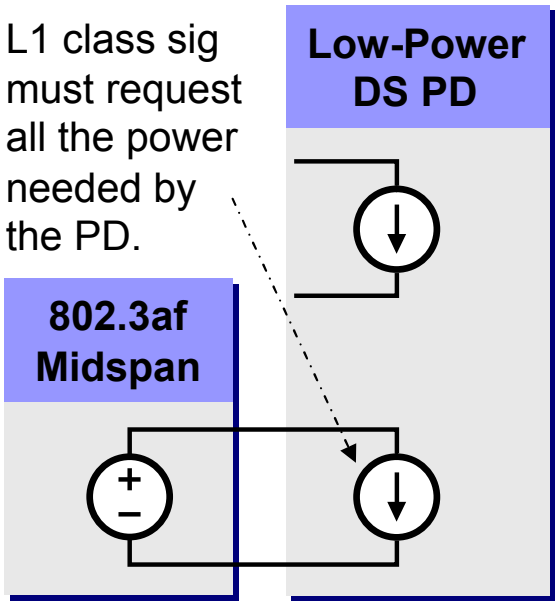
Power Management Issues

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

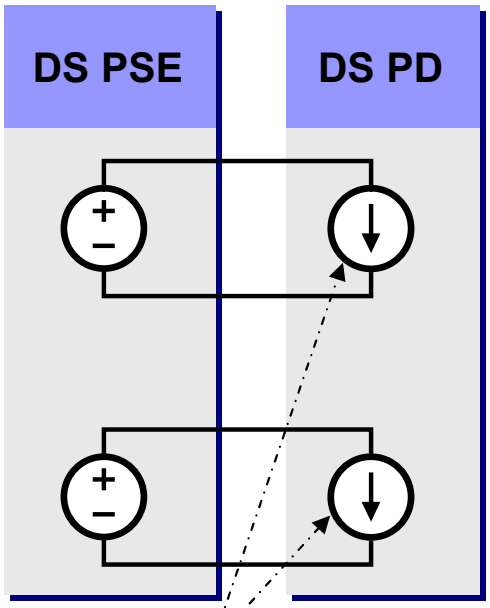
Case 1



Case 2



Case 3



Total requested power is ***double*** what the PD needs.

Dual Signature Topology

Power Management Issues (continued)

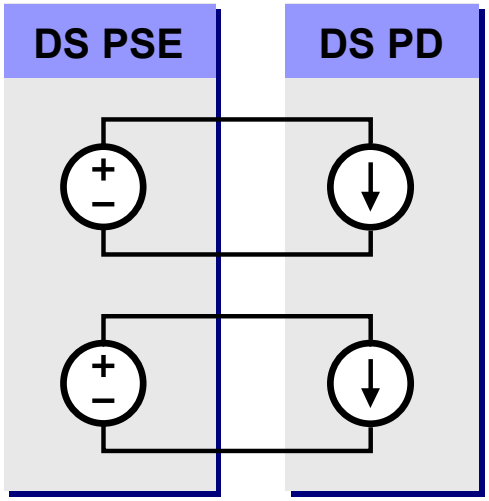
- 1st Possible Solution: Outlaw cases 1 and 2.
  - 4P would be used only by high-power PDs (>26W).
  - Each side of the DS PD requests 50% of the required power.
- Unfortunately this solution has some serious drawbacks:
  - It violates objective 13 of 802.3at Task Force: “PoE Plus PDs within the power range of 802.3af will work properly with 802.3af PSEs”.
  - Also violates objective 14. (Same as 13, but in table format.)
  - 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

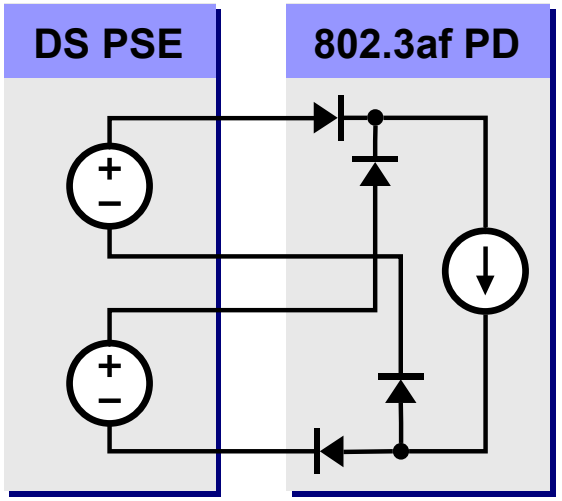
Power Management Issues (continued)

- 2nd Possible Solution: A smarter DS PSE
  - Each side of the 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



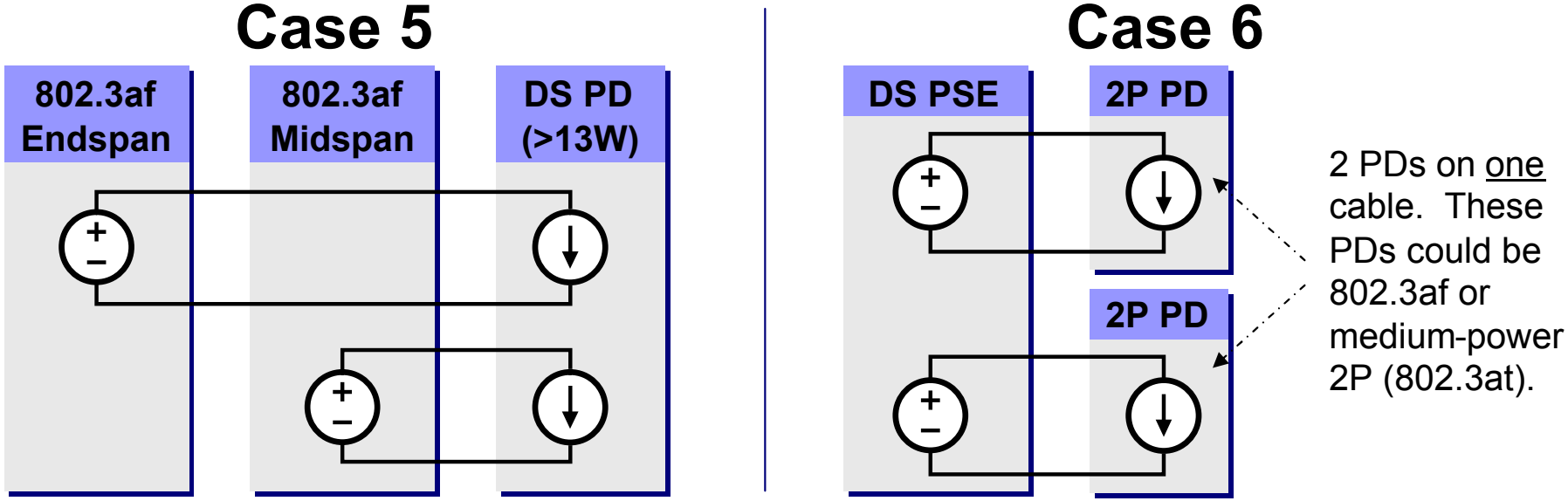
Case 4



Dual Signature Topology

Power Management Issues (continued)

- Unfortunately, the 2nd solution doesn't work with cases 5 or 6.
  - Case 5 represents one of the main advantages of the DS topology. If we choose not to support case 5 then DS becomes much less attractive.
  - But what about case 6? *Do we need it?*
  - If we really need cases 5 and/or 6 then SS is ruled out.



Dual Signature Topology

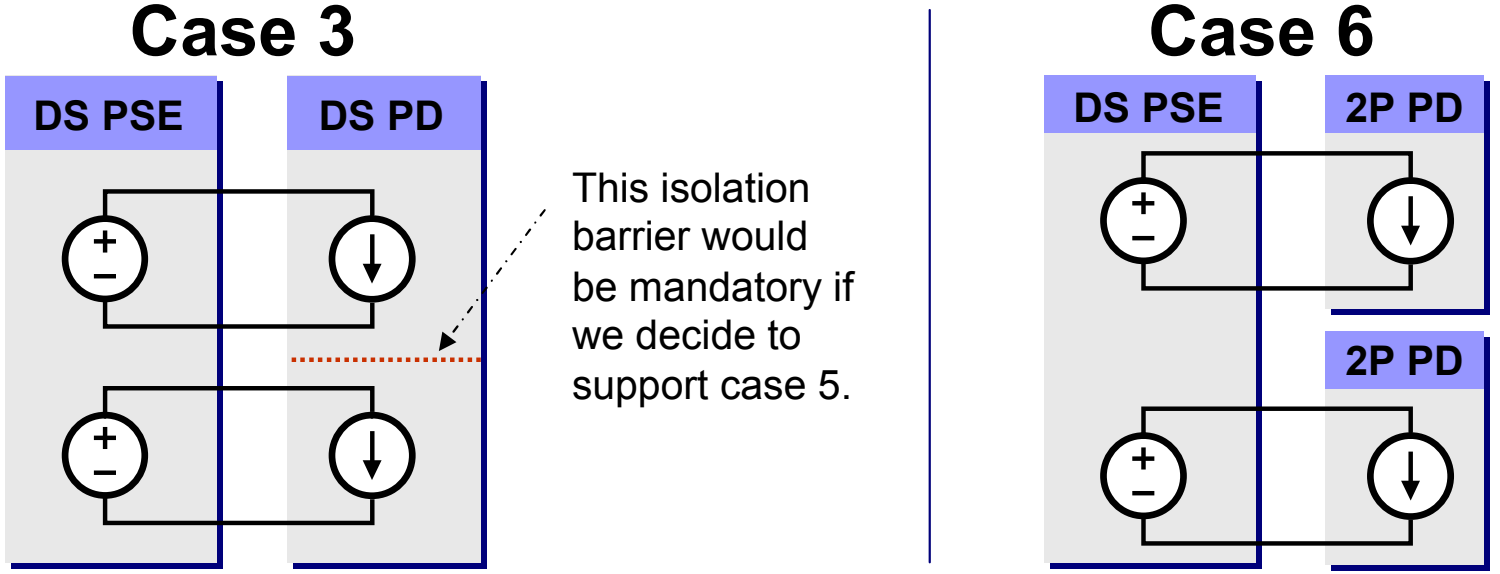
Power Management Issues (continued)

- 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 would set valid detection signatures on both sides.
- This solution could probably work with all cases, however:
  - Obviously this is pretty complex, and probably expensive.
  - PD would have to 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. (We could outlaw case 6, but how would be prevent the PSE from turning on power?)



Single Signature Topology

Advantages and Disadvantages

- Advantages
  - PD is much simpler and probably much less expensive.
  - No inherent power management issues.
  - The test equipment is simpler.
    - Existing PSE testers could still be used in many cases.
- Disadvantages
  - Can't support cases 5 or 6. (But do we really need to?)
  - Current sharing is not inherent, as it was with isolated-DS. We might need Active Current Sharing (ACS) circuitry.
    - If ACS is implemented in the PD, then the PD will be more expensive. But ACS would probably only be needed for very high power PDs. Low-power PDs could simply omit ACS.
    - If ACS is implemented in the PSE, then the PSE will be more expensive, and increased heat dissipation.

What Do We Really Need?

- Do we need cases 5 or 6?
  - These cases are not included in the official objectives of the 802.3at Task Force.
  - Users could avoid replacing 802.3af endspans by using 802.3at midspans. Dumping case 5 probably wouldn't cost them a lot.
  - These cases would rule out SS and force us to use DS with isolation between PD inputs.
    - PDs will be more expensive.
    - No good solutions yet for power management issues.
    - Would probably need to replace existing testers.
- Do we need redundant power?
  - Again, not included in official objectives.
  - No major new market segments depend on it (as far as I know).
  - Redundancy is easier with DS, but probably could be done with SS also.

Summary

- The classification adhoc committee can't complete its work until a decision is reached by the Task Force, selecting either 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 and the PD must have isolation between its inputs.
  - If not, then SS seems to be the best topology based on cost and complexity.
- DS has at least 2 power management issues that don't seem to have any good solutions. But they might not be show-stoppers. (Depends on cases 5 and 6.)
- The cost impact on test equipment should be a factor in the decision.