Layer 1 Cooperative Power Management in Dual PSE Systems

Steve Robbins

Outline of Presentation

- A brief review of PD types.
- A serious interoperability issue is identified.
- A brief look at some bad solutions.
- Proposal for a new protocol that fixes the problem, and offers some other benefits.
- Conclusion.

PD Types (Preliminary)

- Single-Signature (SS)
- Dual-Signature (DS)
  - Each class signature requests 50% of the total power needed by the PD.

PD Type	Power * Range (W)	Input Structure
Low Power	0 to 15.4	SS
Medium Power	15.4 to X	SS or DS
High Power	X to $2X$	DS

X is still TBD. Depends on max current on 2P.

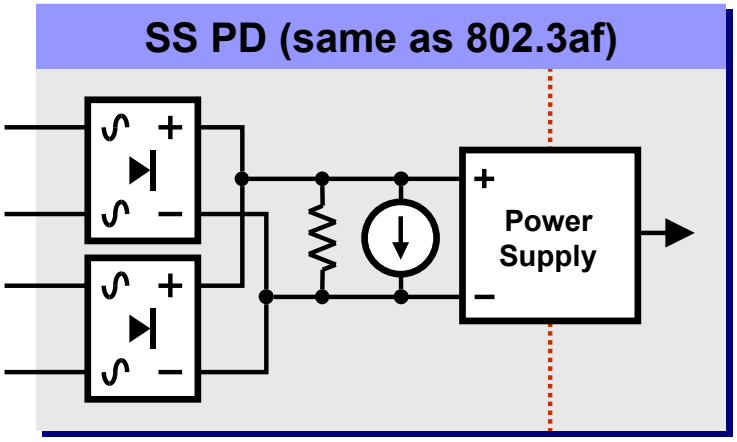
* Power levels at PSE outputs.

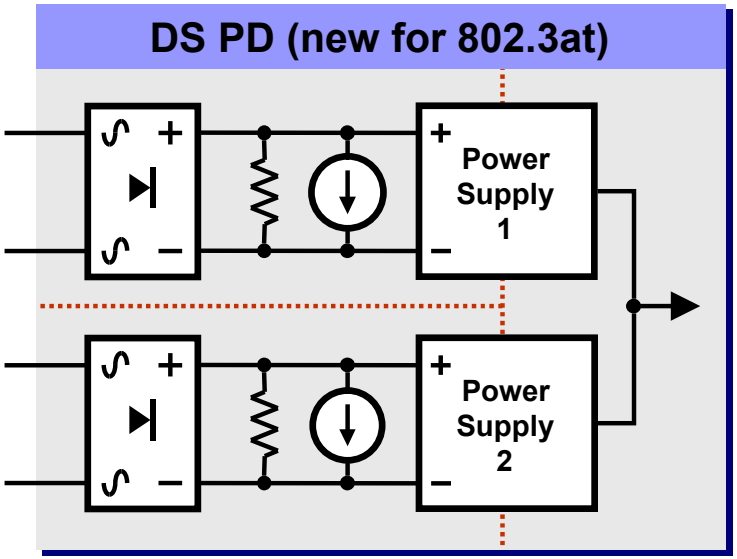
Symbol Legend

= L1 Class Signature

= Detection Signature

= Isolation Barrier





The Typical Upgrade Path

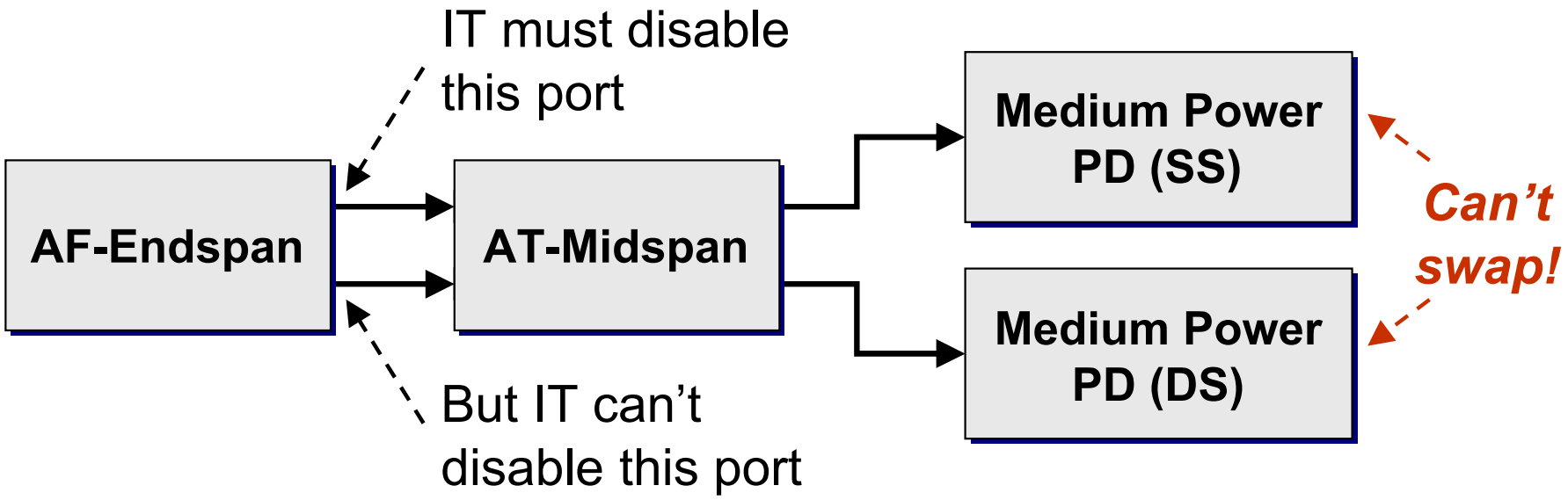
- Suppose a customer wants to use a new SS PD that requires 20W.
- Their old AF-endspan can't power this PD, so they buy a new AT-midspan.
- This setup should work, right? *Wrong!*

Why it Doesn't Work

- For this setup to work, the AT-midspan must power the PD, since the AF-endspan can't.
- But the endspan will usually (perhaps always) power the PD.
  - Midspans have a detection back-off period but endspans don't.
  - No guarantee the midspan will *ever* get a chance to detect and power the PD.
- *This is a serious interoperability problem that must be addressed in the standard.*

A “Simple” Solution?

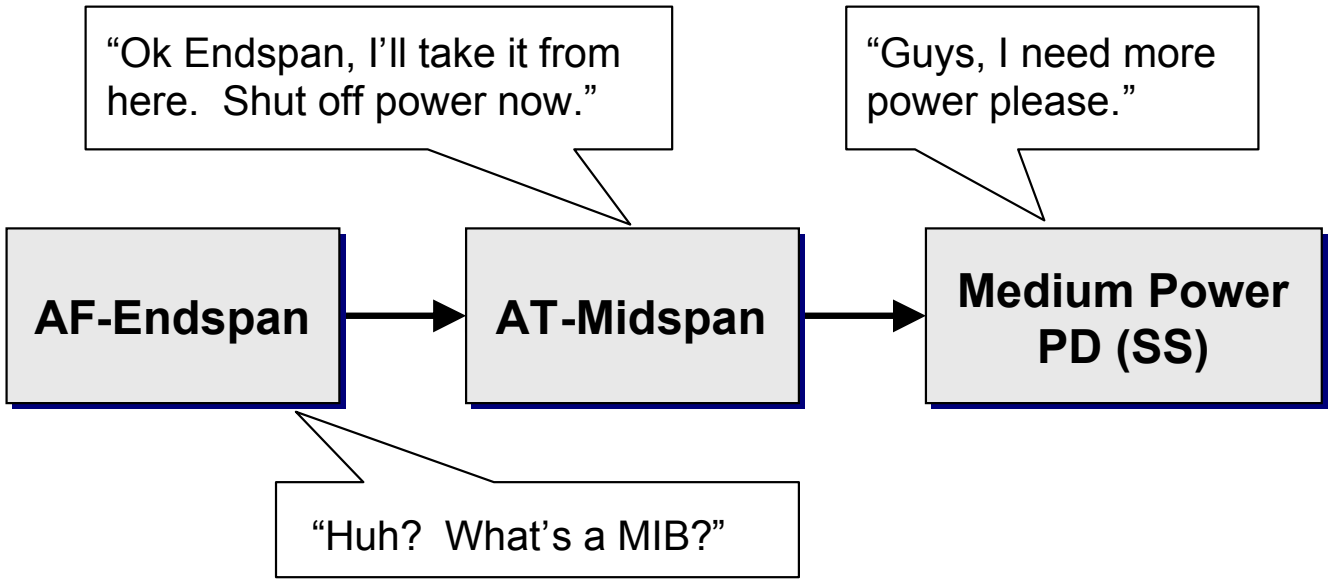
- Why not just have IT disable the endspan?



- If the users want to move or swap PDs they have to call IT first. (Would *you* be happy with this?)

How About a Layer 2 Solution?

- It can't work! Even if we required all AT-midspans to be data-aware, the AF-endspan still wouldn't understand any new L2 protocol.



- We can't require new software for all the old endspans.

Can We Just Tweak 802.3af?

- Could we tweak the detection voltage levels or timing parameters such that the midspan has a chance to detect the PD?
  - Timing tweaks can't work. There is no *window* for the midspan detection waveform to squeeze into.
  - Voltage level tweaks can't work. We'd need >30V!
- Doesn't work.

What We Would Like to See

- The system should be *plug-and-play*.
  - Shouldn't need IT support just to power a PD.
  - Shouldn't need IT support when PDs are moved or swapped.
- The system should automatically utilize *both* PSEs in some logical, deterministic way.
  - All the low-power PDs go to the AF-endspan, until it runs out of power budget and starts rejecting PDs.
  - All the medium-power PDs go to the AT-midspan.
  - Any low-power PDs that are rejected by the endspan get picked up by the midspan (if it has the budget).

“Cooperative” Management

- The AT-midspan must always detect the PD first.
  - *This requires the midspan to have some means of inhibiting the endspans detection process.*
- Then the AT-midspan performs classification:
  - If the PD requests >15.4W and the midspan has enough power budget remaining, then the midspan powers the PD.
  - Otherwise the midspan allows the endspan to attempt to detect, classify, and power the PD.
- If the endspan rejects the PD (or there is no endspan present in the system) then the midspan powers it.
  - *This requires the midspan to have some means of determining if the endspan accepted or rejected the PD.*

Endspan Detection Inhibitor

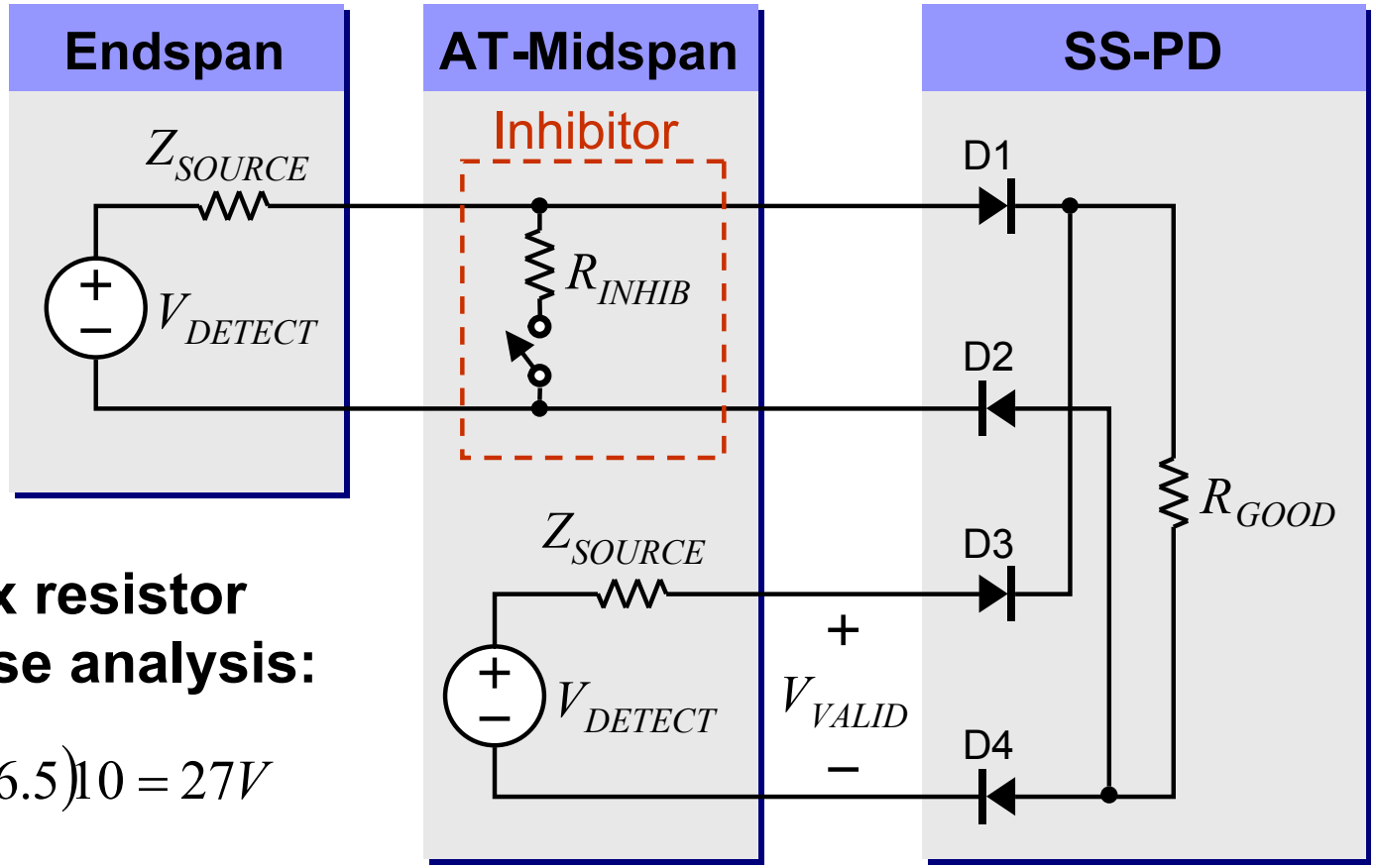
From 802.3af:

$Z_{SOURCE} \geq 45k$

$10V \geq V_{VALID} \geq 2.8V$

$26.5k \geq R_{GOOD} \geq 19k$

$30V \geq V_{DETECT}$ (OC)



Calculation of max resistor value by worst-case analysis:

$$V_{DETECT} \leq (1 + 45/26.5)10 = 27V$$

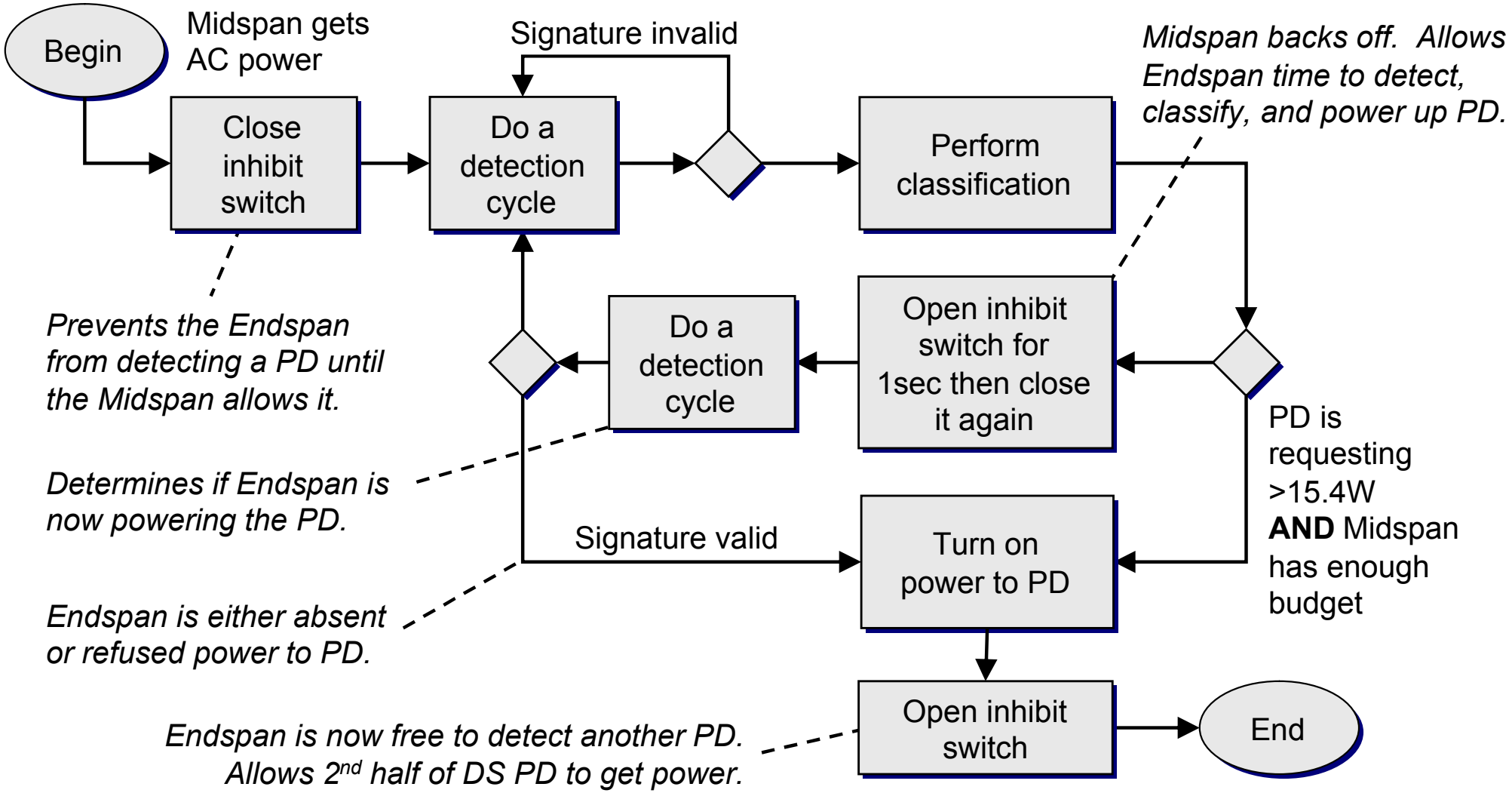
$$R_{INHIB} \leq \frac{45k}{(27/2.8) - 1} = 5.2k$$

How Does it Work?

- When the switch is closed, it does two things:
  - Allows the midspan to detect without interference.
    - R_{INHIB} pulls endspan voltage below 2.8V.
    - Midspan voltage > 2.8V while it attempts detection.
    - Therefore D1 and D2 are reverse biased, temporarily removing the endspan from the circuit.
  - Presents invalid detection signature to the endspan.
- The midspan controls the process according to the flow chart shown on the next slide.
  - Key points are the 1 second back-off period *after* classification, and the extra detection that follows it.

AT-Midspan Detect/Class Protocol

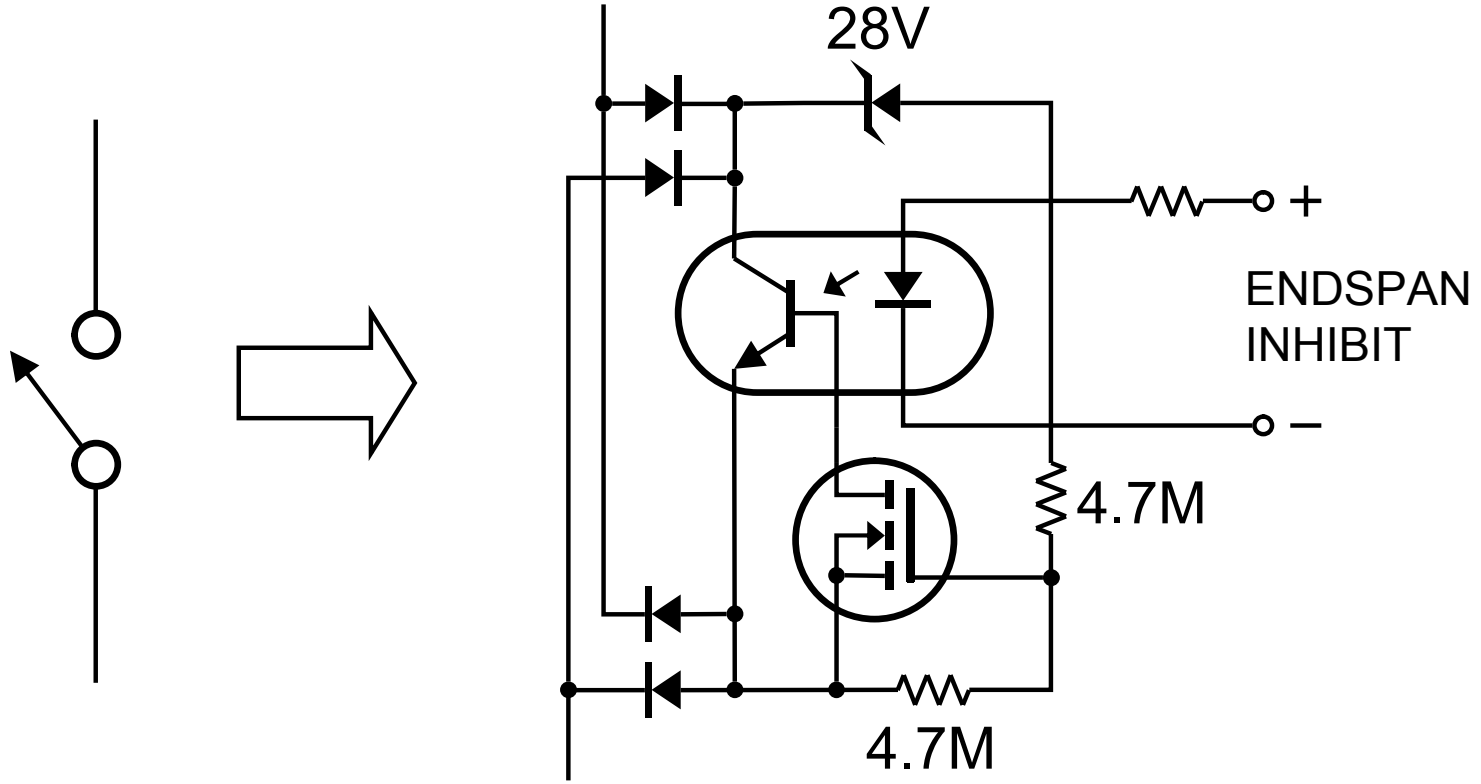
(AT-Endspan would still follow 802.3af protocol)



Switch Requirements

- Overvoltage lockout at approx 30V. Switch must not close while endspan powers PD.
  - Avoids current pulses that could look like DC_MPS.
  - Avoids overheating resistors.
- R_{OFF} >> Z_{AC2} to avoid AC_MPS problems.
- Isolation from chassis and other port circuits.
- Works independent of voltage polarity.
- Rated for at least 80V and 1mA.
- Does not require a power supply.
- Low cost.

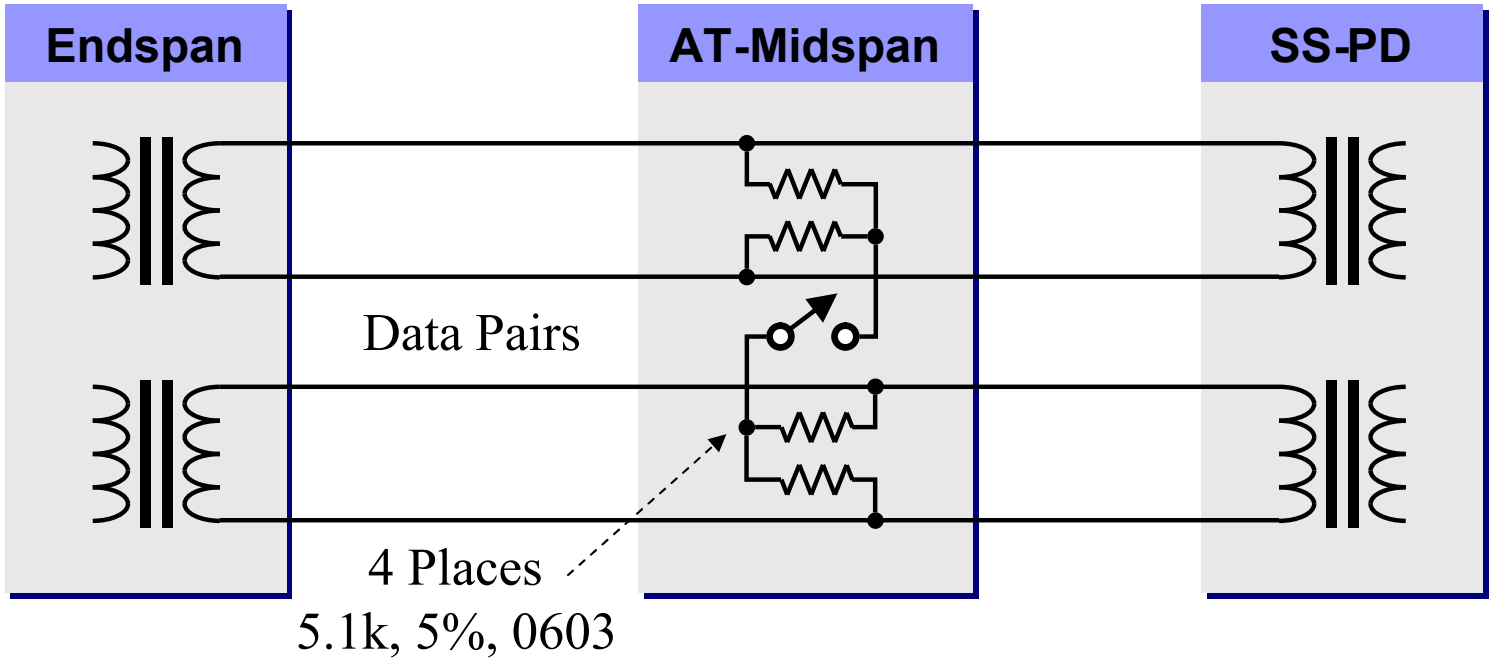
A Possible Switch Circuit



How expensive is this? The material cost of this circuit is approx 50% of what a dual-transformer for a 10/100Base-T interface costs.

Will it Affect Data Integrity?

- No. If laid out properly reflections will be negligible.
  - 10.2k (line-to-line within each pair) >> 100 Ohm characteristic impedance of CAT-5 cable.
  - Small resistors can to be placed directly on traces to avoid stubs.



Conclusion

- The scenario where AT-midspan and AF-endspan coexist will be common. This presents a challenge:
  - For medium power PDs this setup won't work because the AF-endspan detects the PD before the AT-midspan.
  - Therefore we need an improved power management scheme that allows midspan and endspan to work together.
- A simple L1 cooperative power management protocol was presented to fix the problem.
  - A simple circuit allows the midspan to inhibit the endspan without affecting data integrity.
  - The same circuit also allows the midspan to determine if the endspan is powering the PD.