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HUAWEI ENTERPRISE **A BETTER WAY**

# Thinking on 4 Pair PoE Architectures

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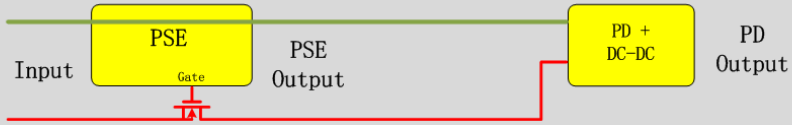
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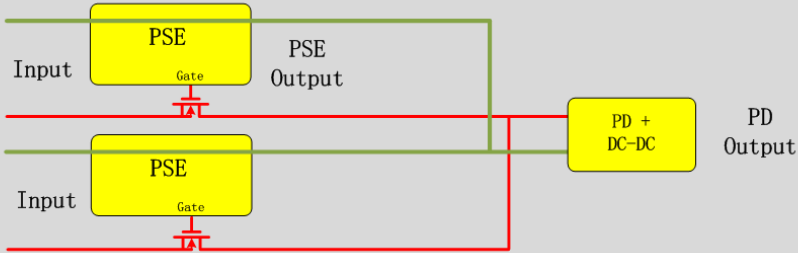
# Outlines

- Potential 4-Pair PoE Architectures
- Gap Analysis of 4PPoE Architectures
- Estimated Costs of 4PPoE Architectures
- Conclusions

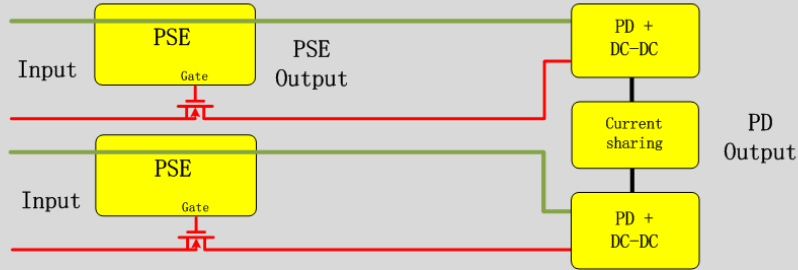
*One  
-by-  
One*



*Two  
-by-  
one*



*Two  
-by-  
Two*



## 4 Pair PoE Architecture

There are three architectures for 4-Pair high power PoE,

- [1-by-1 Architecture](#)
- [2-by-1 Architecture](#)
- [2-by-2 Architecture](#)

Architecture	PSE	PD
1-by-1	1	1
2-by-1	2	1
2-by-2	2	2

**PSE** – A PSE in this presentation represents a PSE controller channel and associated circuitry

**PD** – A PD in this presentation represents a PD controller channel and associated circuitry

**BT Type 3** – Used in this presentation to describe 4P PoE > 25.5W Power (~51W)

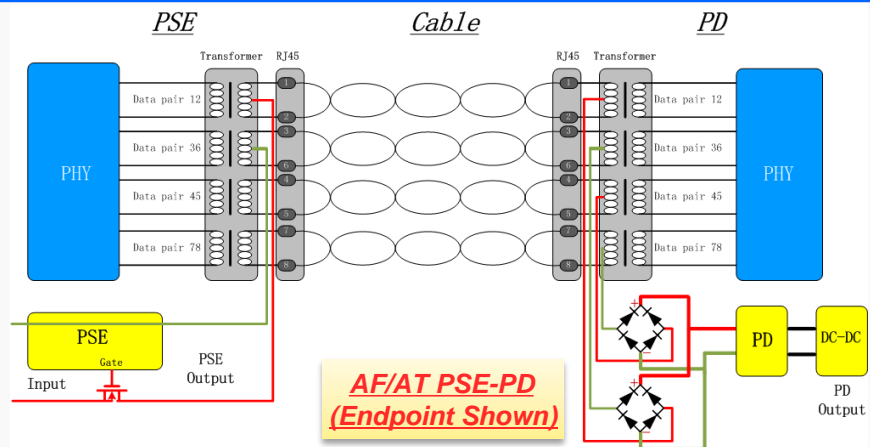
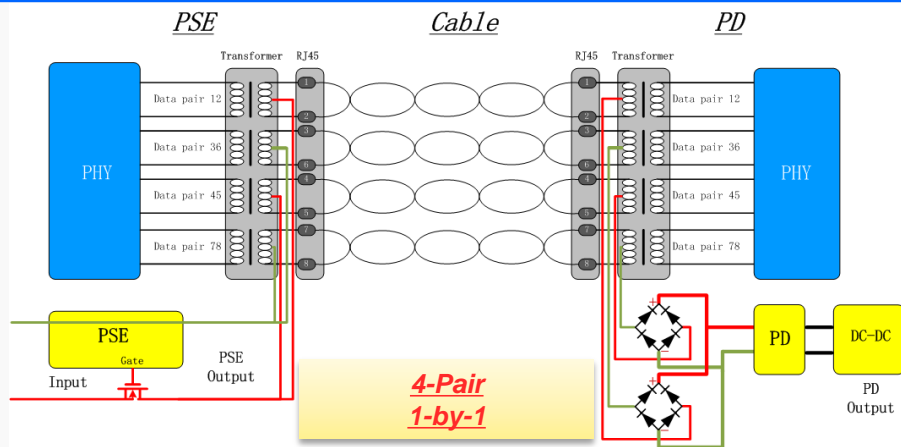
# 1-by-1 Architecture

## One PSE-by-One PD Architecture

Uses 1 BT PSE and 1 BT PD

1 PSE delivers power on 4 pairs

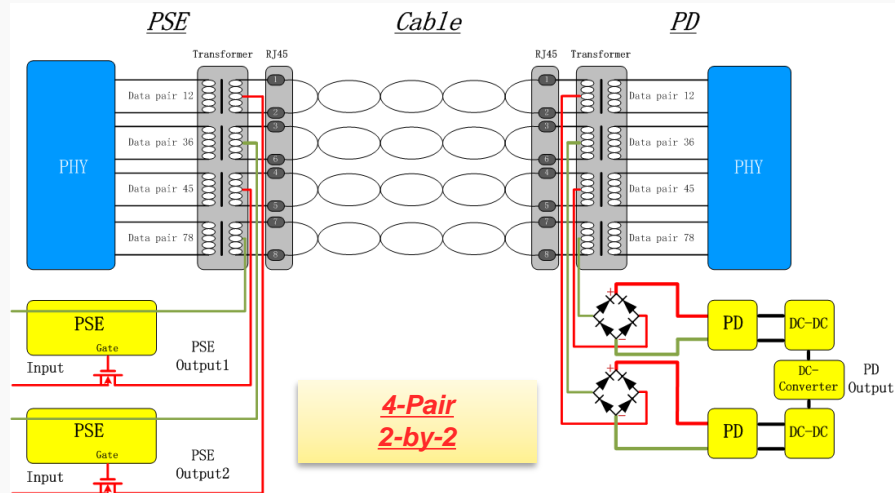
1 PD receives power on 4 pairs



# 2-by-1/Two Architecture

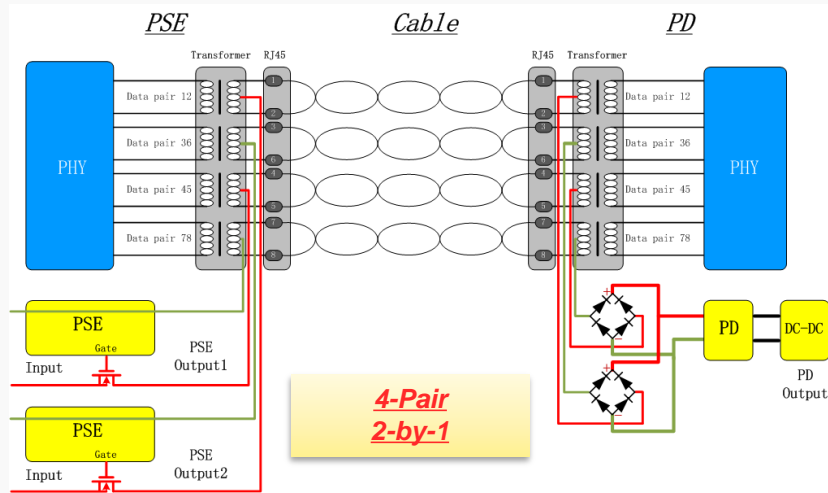
## Two PSE-by-Two PD Architecture

Uses 2 BT PSEs and 2 AF/AT PDs  
Each PSE delivers power on 2 pairs  
Each PD receives power on 2 pairs



## Two PSE-by-One PD Architecture

Uses 2 BT PSEs and 1 BT PD  
Each PSE delivers power on 2 pairs  
1 PD receives power on 4 pairs



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## 4-PAIR POWER OVER ETHERNET CFI

4-Pair Power over Ethernet 10

### Efficiency – Example Use Case

Using the simplified math model from previous slide,

Parameter	Average Case		Worst Case	
Voltage (at PSE)	48.834 V		50 V	
Voltage (at PD)	48 V		48.834 V	
PD Power	8 Watts		25.5 Watts	
Link Resistance	0.125 Ohms/meter			
Link length	40 meters		100 meters	
Hours in a Year	8760 Hours			
Cable Power Loss Per PD	2-PAIR	4-PAIR	2-PAIR	4-PAIR
	0.14 W	0.07 W	4.5 W	2.25 W
Loss Percentage Per PD	1.71%	0.854%	15%	7.5%
Cable Power Loss per PD per Year	1217 Watt-Hours	608 Watt-Hours	39420 Watt-Hours	19710 Watt-Hours

With a conservative assumption of 100million PDs deployed world wide, the average cable power loss numbers are, (average case from table above)

- Cable Power loss over all PDs/year on a 2-pair system → 121.7 Million kWh
- Cable Power loss over all PDs/year on 4-pair system → 60.8 Million kWh

Potential Energy Savings from 4-pair system → (at least) 60.8 Million kiloWatt-hours/yr

CFI and 5 Criteria require 802.3at Type 1 and 2 PDs to be powered over all 4 pairs in order to increase power efficiency

## 4-PAIR POWER OVER ETHERNET 5 CRITERIA

### Economic Feasibility

For a project to be authorized, it shall be able to show economic feasibility (so far as can reasonably be estimated) for its intended applications. At a minimum, the proposed project shall show:

- Known cost factors, reliable data.
- Reasonable cost for performance.
- Consideration of installation costs.

Extrapolation from the experience of over a decade of installed devices provides a reliable baseline. The power supply industry is well established and has many years of practice. The cost factors are well known.

In the expected range of increased power capability, there is a declining curve of cost per watt. Additionally, increased power efficiency by moving to a 4-pair system and intelligent power management will reduce operational expenses (OpEx) for PoE systems.

PoE installation costs have been demonstrated to be significantly lower in most cases when compared to traditional powering methods that rely on a separate power distribution systems. The utilization of the additional wire pairs to carry power increases efficiency and power delivery at no additional cabling cost.



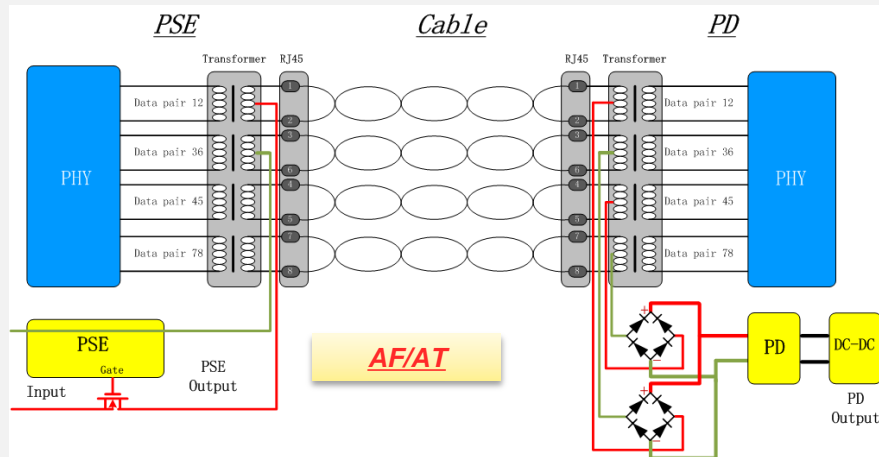
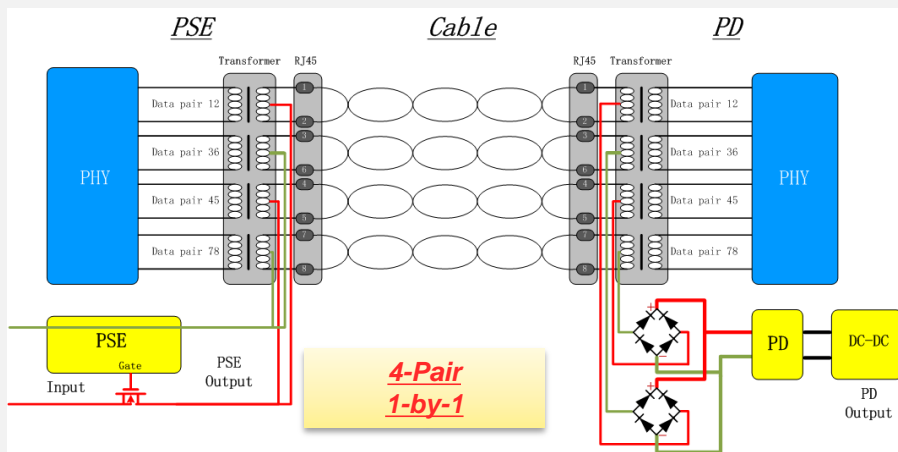
- For this evaluation, the PoE process will be divided into 6 procedures of interest:

Idle, Detect, Class, Power up, Power on and Disconnect

- Based on the previous potential 4-Pair PoE architectures, we'll study:
  1. How these 4PPoE architectures leverage 802.3at/af standards
  2. Point out technical gaps with the at/af standard

# 1-by-1 Architecture Gap Analysis

There is only 1 PSE in both architectures  
The 4-Pair PD N-by-1 architecture is the same as AT/AF PD



## Reuse of the existing standard:

The idle, detect, power up, and disconnect procedures are the same as AT/AF standard.

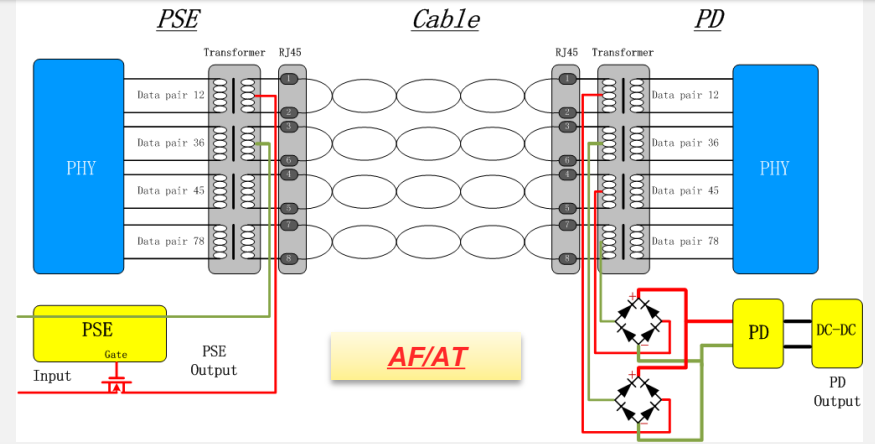
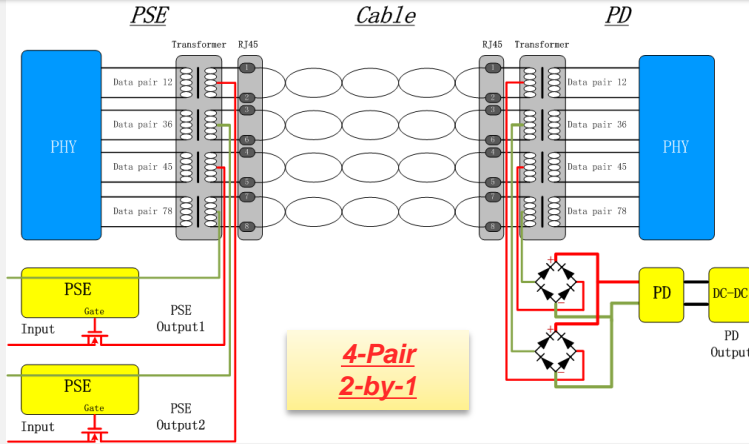
## Gaps between AT/AF and 4-Pair 1-by-1 architecture:

1. **Class:** New class bin to be added
2. **Power-on:** A new higher current level is provided

# 2-by-1 Architecture Gap Analysis

How to use 2 PSEs to control only 1 PD?

The 4-Pair PD N-by-1 architecture is the same as AT/AF PD



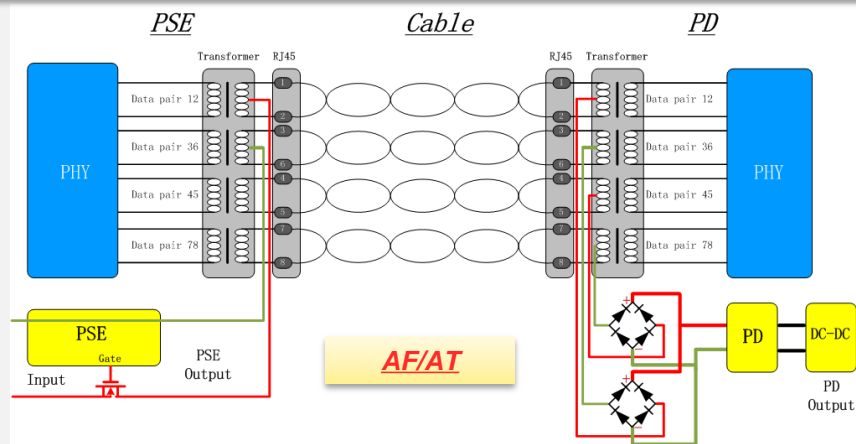
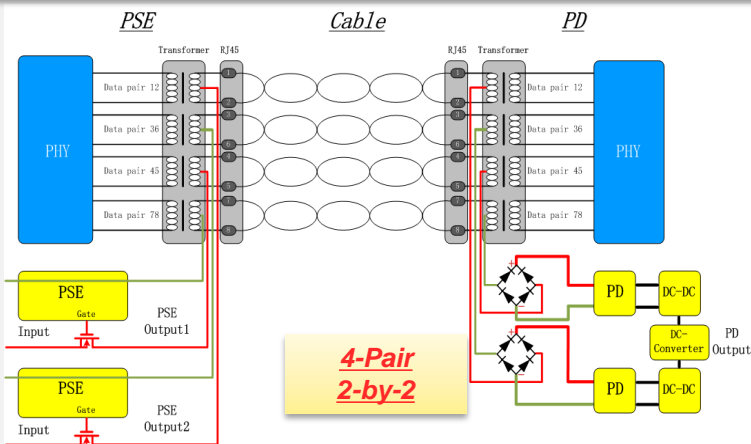
## Reuse of the existing standard:

The idle procedure is the same as AT/AF standard

## Gaps between AT/AF and 2-by-1 architecture:

- Detect:** PSE detections can collide and pollute each other. Careful time-sharing definition and sequencing is required.
- Class:** PSE classifications can collide and pollute each other. Careful time-sharing definition and sequencing is required.
- Power Up, Power-on:** Each PSE provides half the inrush current. Due to known current imbalance issues, currents from each 2-pair side must be summed in real-time for the purpose of tracking cutoff, limit and dc disconnect.
- Disconnect:** Consumes twice the 802.3at MPS power (or more due to small but significant current imbalances.)

How to use 2 PSEs to control only 1 PD (when AF/AT PD is connected)?



## Reuse of the existing standard:

The idle procedure is the same as AT/AF standard

## Gaps between AT/AF and 2-by-2 architecture:

- Detect:** PSE detections can collide and pollute each other when AF/AT PD is connected.
- Class:** PSE classifications can collide and pollute each other when AF/AT PD is connected.
- Power Up, Power-on:** Each PSE provides half the current when AF/AT PD is present. Due to known current imbalance issues, currents from each 2-pair side must be summed in real-time for the purpose of tracking cutoff, limit and dc disconnect.
- Disconnect:** Consumes twice the 802.3at MPS power (or more due to small but significant current imbalances.)

**Conclusion:**

1. The 1-by-1 design **naturally inherits the 802.3at standard** with simple class and power-on current extensions.
2. The 2-by-N designs **need added controls in detect, class, power up and power on, and disconnect procedures.**
3. The 2-by-N designs **consume around twice the standby power as 802.3at does.**

Mode	PoE Status					
	Idle	Detect	Class	Power up	Power on	Disconnect
1-by-1	AF/AT	AF/AT	New <sup>1</sup>	AF/AT	New <sup>2</sup>	AF/AT
2-by-1	AF/AT	New <sup>3</sup>	New <sup>3</sup>	New <sup>4</sup>	New <sup>5</sup>	New <sup>6</sup>
2-by-2	AF/AT	New <sup>3</sup>	New <sup>3</sup>	New <sup>4</sup>	New <sup>4</sup>	New <sup>7</sup>

**Note:**

1. Requires a **new** class for higher power delivery.
2. Requires a **new** current cutoff and limit for higher power delivery.
3. Requires **added controls** in detect and class procedures and direct coordination between PSEs.
4. Requires **added controls** in power up and power on procedures. Real-time summing of currents complicates hot swap, cutoff and DC disconnect.
5. Requires **added controls** in power on procedure; procedures differ depending on discovered PD type.
6. Consumes (at least) **twice the 802.3at MPS power.**
7. Consumes (at least) **twice the 802.3at MPS power.** Complicated by discovered PD type.

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- 2-by-N architectures incur the following additional costs as compared to a 1-by-N solution:
  - **2x hardware cost** due to duplicated hardware
  - **Added controls** for:
    - Detection and Classification – Sequencing requirements
    - Power-up, Power-on and Disconnect – real-time current summing for cutoff, limit and dc disconnect
  - Possible **IP licensing costs**

- N-by-2 architectures incur the following additional costs as compared to a N-by-1 solution:
  - **2x hardware cost** due to duplicated hardware
  - Possible **IP licensing costs**



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From previous analysis on technical gaps, compatibility and estimated costs of the 4-Pair PoE architectures:

- N-by-1 PD design fully adopts the AT/AF design and supports requesting and receiving BT Type 1/2/3 from all 4-Pair PSE architectures and remains backwards compatible with AT/AF PSEs.
- 1-by-1 PSE design supports 1-PD design in AT/AF PoE as well as BT Type 3 levels with only the addition of a higher power classification bin.
- 1-by-1 architecture is the most efficient and cost-effective choice for 4-Pair PoE design.

# Thank you!