IEEE P802.3bt Mutual Identification

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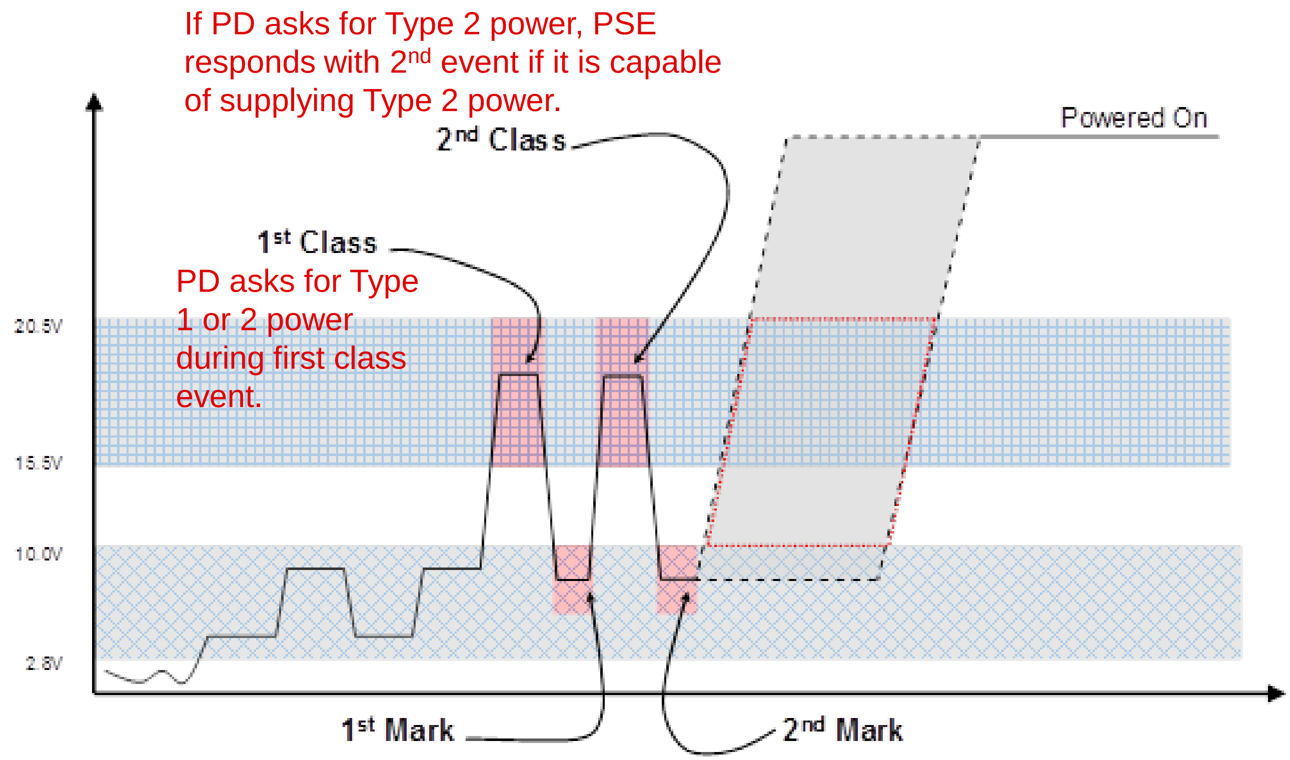
Goals of this Mutual ID Proposal

- Keep it simple
  - A direct extension of what is already done makes the most sense.
  - Make sure it is cheap for the PD to implement.
- Cover all power levels
  - Make sure all PSEs can classify from 0W to their max power level.
  - Have multiple types of PSEs to allow for cost optimization.
- Make it backwards compatible
  - Any PSE should have the ability to power up any PD (at whatever power level it can provide).
  - Any PD should be able to receive power from any PSE.

Mutual ID: A Review

- The main objective of mutual identification is for both the PD and PSE to learn the capabilities/requirements of the other.
  - The current standard reads: “Mutual identification is the mechanism that allows a Type 2 PD to differentiate Type 1 PSEs from Type 2 PSEs. Additionally, mutual identification allows Type 2 PSEs to differentiate between Type 1 and Type 2 PDs.”

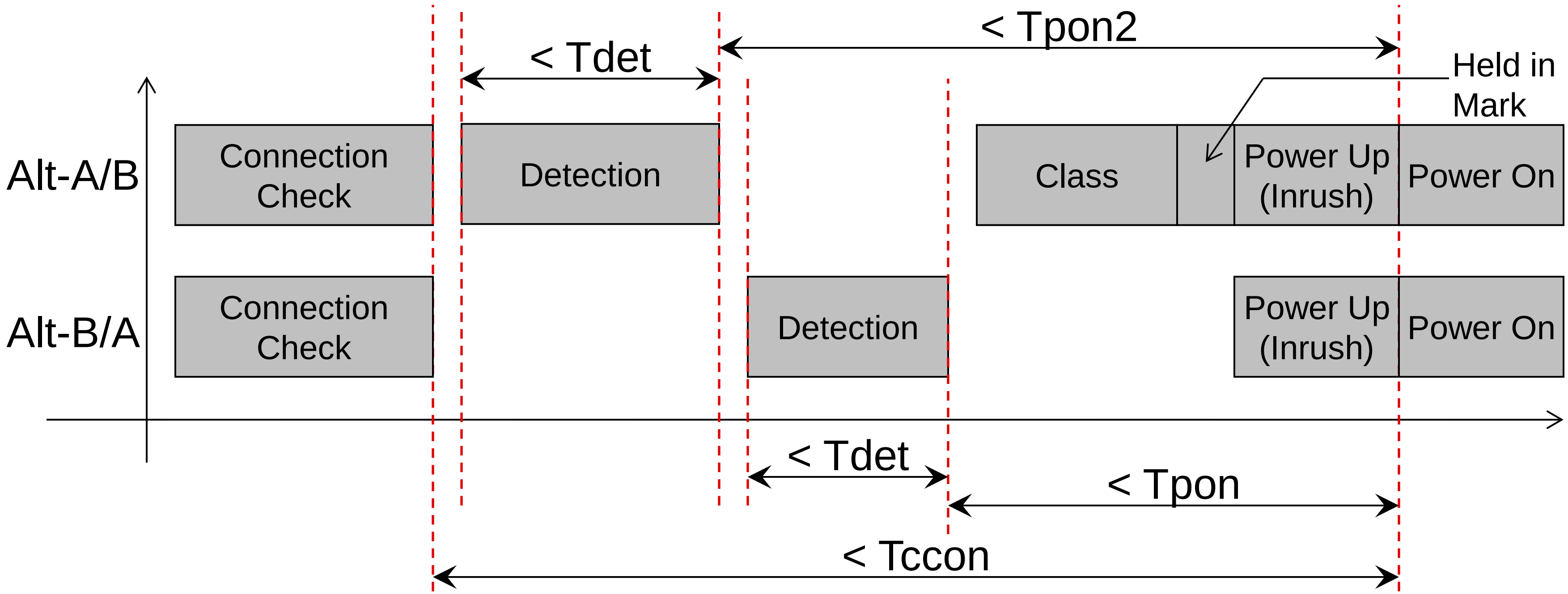


Connection Check: A Way to Simplify Things

- A connection check* can be used to determine if the PD is a single or dual load architecture.
  - If the connection check reveals that the PD is a single load:
    - Detection should be performed on both alternatives before powering up.
    - Classification only needs to be performed on a single alternative since both alternatives are connected together.
    - T_{pon} (the time from the end of detection to power on) would be measured from the end of the 2^{nd} detection, but additional timing requirements must be added to make sure there is not long delays (where the load could be switched) between the connection check and the 1^{st} detection or the 1^{st} and 2nd detection.
  - If the connection check reveals that the PD is a dual load:
    - Detection and classification would be performed on each alternative.
    - The detection and power up timings would not change from .3at.

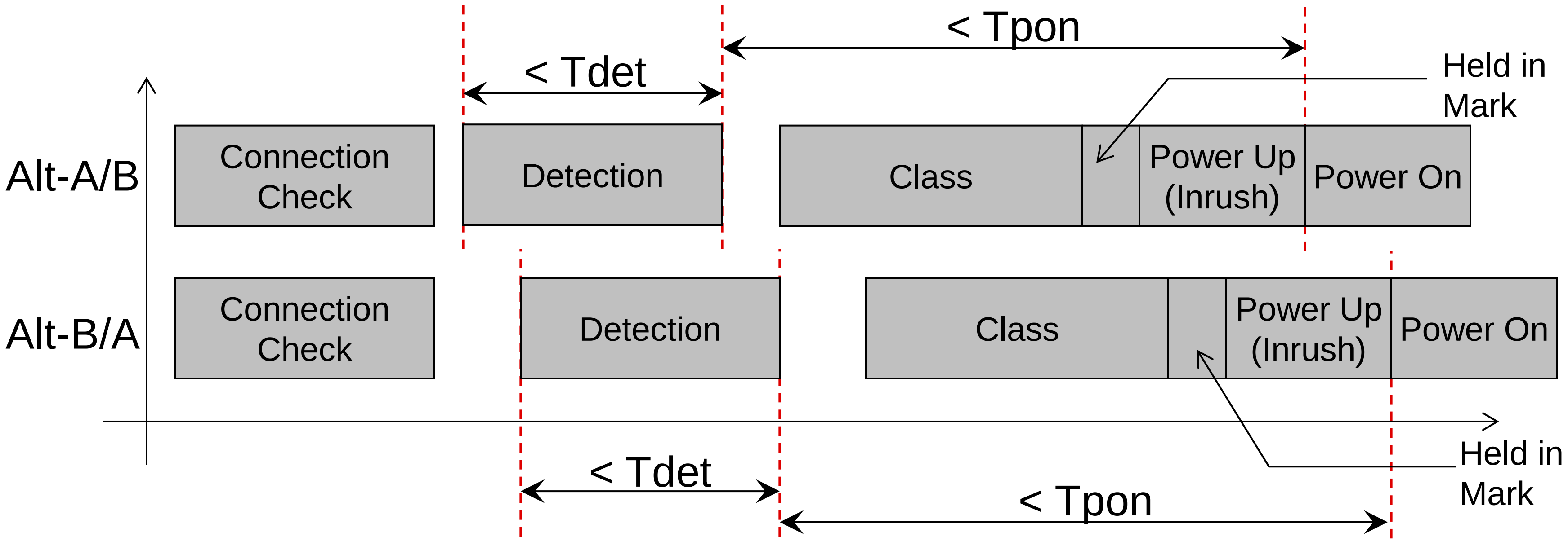
*See Annex A for more information about the connection check.

Timing Diagram: Single PD Load



- The timings for a single load turn on are:
  - Existing Tdet and Tpon timings can be used for the 2nd alternative that detection is performed on.
  - The 1st alternative must reach power on state within Tccon from the end of the connection check.
    - This ensures that the single PD load cannot be disconnected and replaced by a dual PD load (or other load) between the connection check and power on.
    - Tpon requirements for the first alternative (Tpon2) can be relaxed/removed because we know it is a single PD load and detection is being performed on the 2nd alternative.

Timing Diagram: Dual PD Load



- Each channel can be treated separately, so the timing requirements are the same detection time (Tdet) and power turn on time (Tpon) in the current standard.

Legacy Devices

- The connection check also allows us to safely power legacy devices.
  - If the connection check reveals a single load legacy PD
    - Both alternatives are connected through a bridge before the PD.
    - Powering the PD over 2 or 4 pairs should not change its behavior.
    - The PD will only draw the power it requests during classification.
  - If the connection check reveals a dual load legacy PD:
    - Detection should be staggered by at least 900ms (Tdet + Tpon) in order to check to see if the PD accepts power over 4 pairs. This gives time for the PD to provide an invalid detection signature on the 2^{nd} alternative once the first alternative is powered.
- If we power legacy device over 4 pairs, we do not need new mutual ID for power levels covered by .3at.
  - However, PDs that operate at these power levels still need a way of knowing if they are connected to a .3bt PSE so that they can take advantage of the new MPS timings.
  - In order to let new PDs know they can use the new timings, etc. a 4-pair PSE can send a long class event (>30ms) on the first event. Only PDs that will perform MPS pulsing (which requires timing circuitry) will need to measure the length of the event.

The Need for 2 New Types

- Since the new standard will be adding coverage for a range of power from 30W (sourced) up to 100W, it requires the addition of at least two new Types due to:
  - Cabling
    - The current cabling standards sited in 33.1.4.1have been shown to be capable of carrying the current necessary to deliver 2x .3at power levels (60W sourced, ~51W delivered).
    - New cabling will need to be dictated for systems that operate over these limits.
  - Volume and optimization
    - The highest volume of new equipment (>30W) will be concentrated at the lower end of the range (between 30W and 60W).
    - Having a dedicated Type for these systems allows for cost optimizations as they can use a lot of the same components as current PoE systems.
  - PD Power Demotion
    - Adding two new Types allows an intermediate power level (between 30W and 100W) to be negotiated via layer 1. A Type (with its own mutual ID) allows the PSE to tell the PD how much power it will provide if it cannot supply all of the power requested by the PD.
    - Adding a Type between maximum power and 30W allows high power PDs to be powered at this intermediate power level rather than being demoted to Type 2 power.

A Direct Extension of .3at Mutual ID

- In order for PDs operating above .3at power levels (>25.5W) to be powered up by Type 1 and Type 2 PSEs, they must present class 4 for the first two class events.
  - They will be powered at the maximum power level the PSE is capable of.
- Thus, Type 3 and Type 4 PDs will request their required power level on the 3rd event. The existing class levels will be used to do this and the same class used for the 3rd event will be repeated during any additional events.
  - This allows the PD implementation to use only 2 class resistors.
- Since Type 3 will encompass multiple class levels, a additional class event will be needed to confirm the PSE can supply the power requested by the PD.
  - Example: The PSE has 50W left in its power budget.
    - If a PD requests 60W on the 3rd event, the PSE powers on after the 3rd event indicating that it does not have the power available and that it will provide 30W.
    - If a PD requests 45W on the 3rd event, the PSE provides a 4th event before powering on as a confirmation that it will supply the requested power.

Mutual ID: A 5 Event Solution.

PD Type	Class	Power Sourced*	Event 1 (Class)	Event 2 (Class)	Event 3 (Class)	Event 4 (Class)	Event 5 (Class)
Power Level Indicated by Event			2/4-Pair 15W	2/4-Pair 30W	4-Pair 30W	4-Pair Up to 60W	4-Pair 90W
1	0-3	< 15W	0-3	0-3	0-3	0-3	0-3
2	4	30W	4	4	4	4	4
3	5	45W	4	4	1	1	1
3	6	60W	4	4	2	2	2
4	7	90W	4	4	3	3	3

*All power levels referenced to PSE PI.

- There is an additional code (4,4,0,0,0) that is currently unused.
  - Should we use it to add another power level? We could make the available power levels:
    - 15W, 30W, 40W, 50W, 60W, 90W or
    - 15W, 30W, 45W, 60W, 75W, 90W
  - Should we use it to enable AutoClass?

Mutual ID Matrix

PD Type / PSE Type	1	3 (15W)	2	3 (30W)	3 (45/60W)	4 (90W)
1	1 Event 0-3 Power ≤ 15W	1 Event 0-3 Power ≤ 15W	1 Event 4 Power = 15W	1 Event 4 Power = 15W	1 Event 4 Power = 15W	1 Event 4 Power = 15W
3 (15W)	1 Event *0-3* Power ≤ 15W	1 Events *0-3* Power ≤ 15W	1 Event *4* Power = 15W	1 Event *4* Power = 15W	1 Event *4* Power = 15W	1 Event *4* Power = 15W
2	1 Event 0-3 Power ≤ 15W	1 Event 0-3 Power ≤ 15W	2 Events 4, 4 Power = 30W	2 Events 4, 4 Power = 30W	2 Events 4, 4 Power = 30W	2 Events 4, 4 Power = 30W
3 (30W)	1 Event *0-3* Power ≤ 15W	1 Event *0-3* Power ≤ 15W	2 Events *4*, 4 Power = 30W	2 Events *4*, 4 Power = 30W	2 Events *4*, 4 Power = 30W	2 Events *4*, 4 Power = 30W
3 (45/60W)	1 Event *0-3* Power ≤ 15W	1 Event *0-3* Power ≤ 15W	3 Events *4*, 4, 4 Power = 30W	3 Events *4*,4,4 Power = 30W	4 Events *4*,4,1/2,1/2 Power = 45/60W	4 Events *4*,4,3,3 Power = 60W
4 (90W)	1 Event *0-3* Power ≤ 15W	1 Event *0-3* Power ≤ 15W	3 Events *4*, 4, 4 Power = 30W	3 Events *4*,4,4 Power = 30W	4 Events *4*,4,1/2,1/2 Power = 45/60W	5 Events *4*,4,3,3,3 Power = 90W

Note: Class events marked in *red italics* indicate long class event used to identify PSE as Type 3 or 4.
Power levels shown with underline indicates PD can use new Type 3 or 4 functions (MPS timings).

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Achieving the Goals

- Keep it simple
  - Uses only existing classes, with a 3rd and 4th event for Type 3, and a 5th event for Type 4.
  - PD is only required to produce 2 different currents (two pins/resistors required), one current for the first two events, one current for the 3rd, 4th, and 5th event.
- Cover all power levels
  - Adds a Type 3 PSE to cover 0-60W and a Type 4 PSE to cover 0-90W operation.
  - Adds Type 3 and Type 4 PDs to cover up to 60W and 90W respectively.
  - The connection check allows legacy devices to be powered over 4 pairs, removing the requirement for new low-power Types.
- Make it backwards compatible
  - All Type 3/4 PDs begin mutual ID with class 4 signatures for the 1st and 2nd events. This allows them to be powered at 15W/30W by Type 1/2 PSEs respectively.

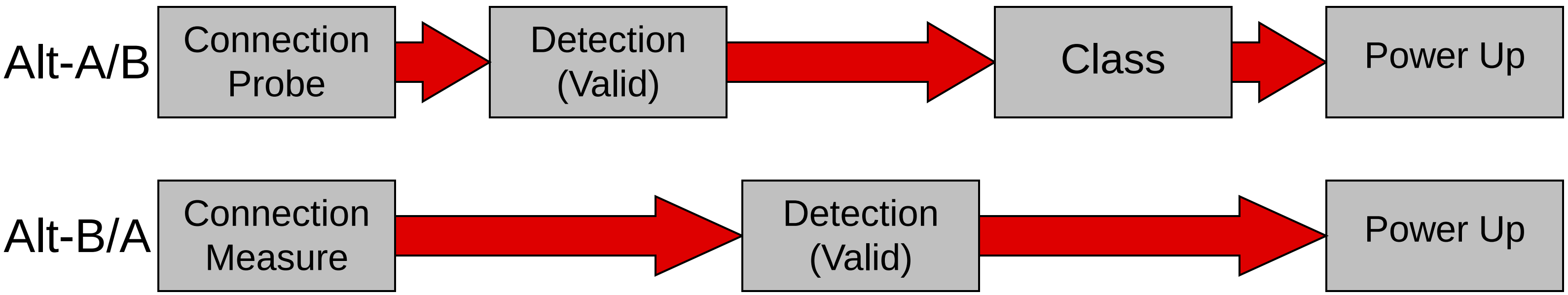
Annex A: Connection Check Revisited

The Connection Check Revisited

- See http://ieee802.org/3/4PPOE/public/nov13/abramson_01_1113.pdf for full presentation that introduced the connection check.
- Connection check is used to determine if the PSE is probing the same PD interface (through a bridge).
- If PSE determines that it is a single PD interface, the power requested by the PD during class is assumed to be the total power for all 4 pairs.
- If PSE determines that it is connected to 2 separate PD interfaces, the power requested by each PD during class applies only to each PDs pair set respectively.
- Connection check can be done using circuitry and methods already used in PSEs.
  - One pair set can be used to corrupt detection on the 2nd pair set.
  - Could use existing circuitry in a new way to create a dedicated check

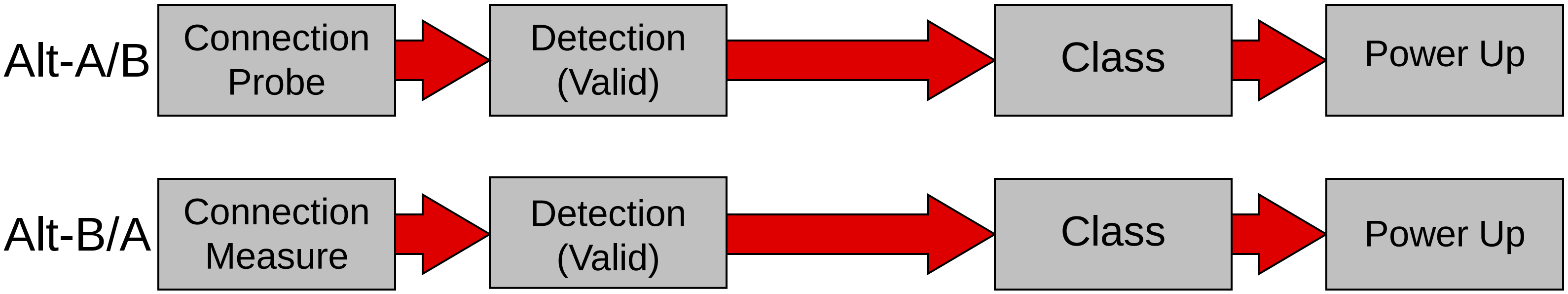
Connection Check: An Example

4PPoE PSE Connected to 4PPoE PD with Single PD Interface



Connection Check indicates (possible) 1 PD interface

4PPoE PSE Connected to 4PPoE PD with Dual Interface PD (or 2 Separate PDs)



Connection Check indicates (possible) 2 PD interfaces

Annex B: A Possible AutoClass Implementation

AutoClass: A Possible Solution

- We can use a single code (4,4,0…) to enable AutoClass at multiple levels.
  - All Type 3 and Type 4 PSEs (operating at 30W or above) must be required to support AutoClass.
  - Type 3 and Type 4 PDs may optionally support AutoClass.
  - The PD would indicate it would like to perform AutoClass during physical layer classification by responding to the third class event (and all subsequent class events) with class 0 current.
  - The PSE would continue to give class event fingers that represented its maximum current.

Total Class Fingers	3	4	5
Power Available	30W	60W	90W

  - The PD would perform AutoClass after power up, but would need to limit itself to the power level indicated by the number of class events.
  - Examples:
    - A PSE capable of supplying 90W provides 5 class events to which the PD responds with 4, 4, 0, 0, 0. The PD then performs AutoClass with a 90W maximum power.
    - A PSE capable of only 30W provides 3 class events to which the PD responds 4, 4, 0. The PD then performs AutoClass with a 30W maximum power.