IEEE802.3at Task Force

An Extended Classification Proposal-
Proposal #1

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PowerDsine

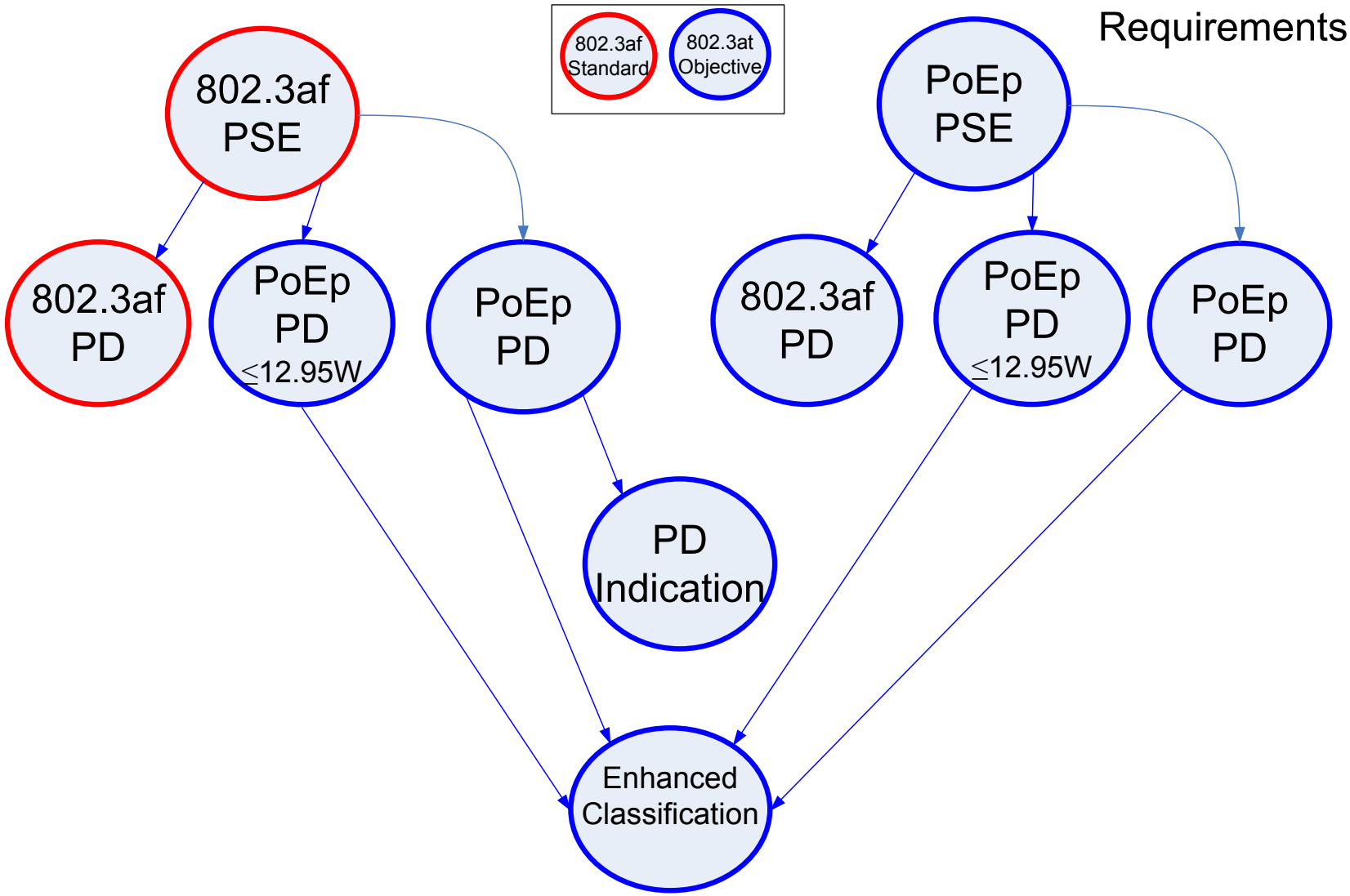
Objectives and Agenda

- Background: Summary of previous discussions and proposals
- Requirements Analysis for Extended Classification Protocol for meeting IEEE802.3at Objectives
- Extended Classification Concept that based on the requirements analysis conclusions and previous discussions
- Discussion

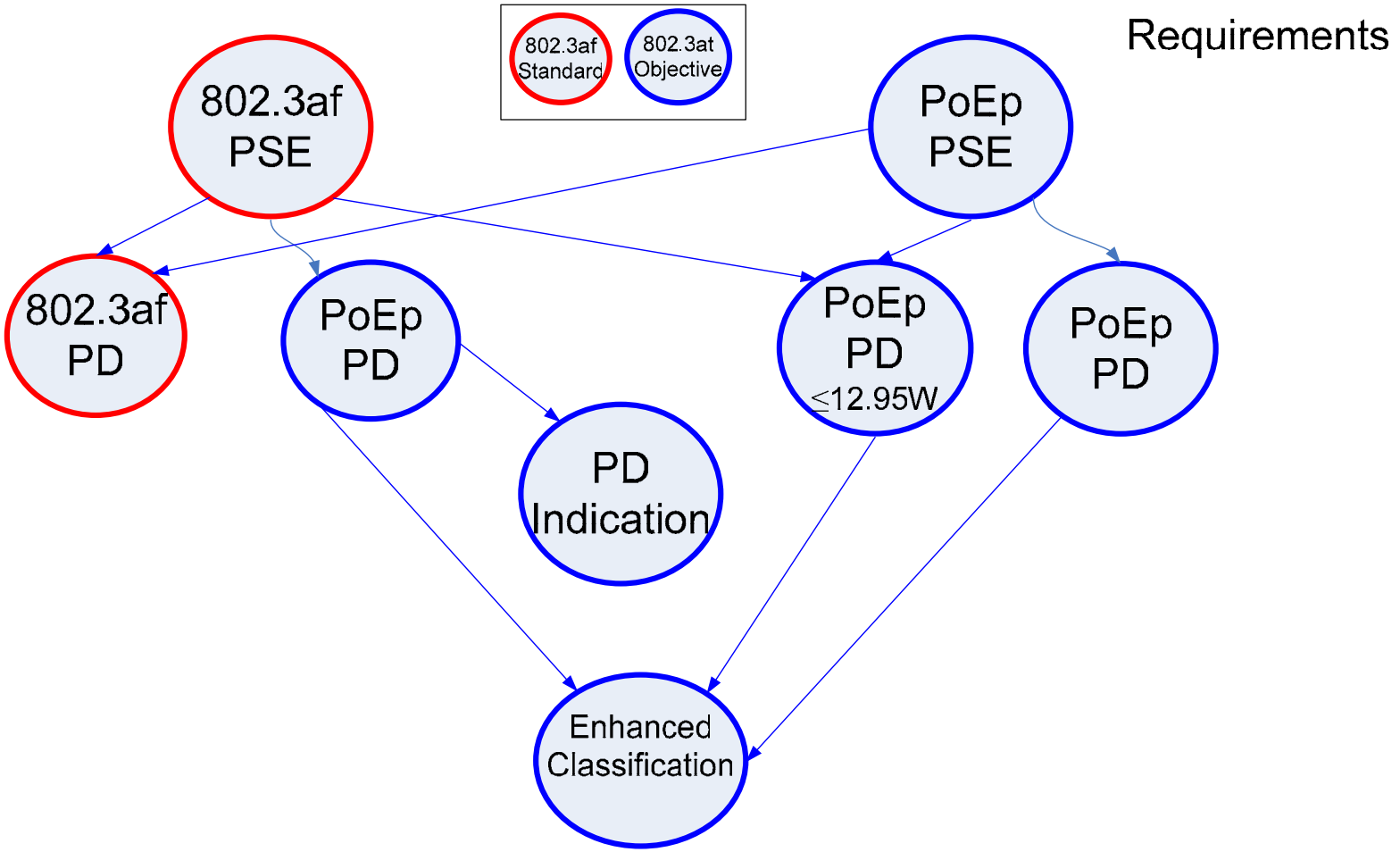
Summary of previous discussions and their inputs

- Achieving High Classification Resolution
  - By reading current level (Iclass-i, i=1,2,3,4) and its time duration Tclass-j, j=1,2..m)[1]
- Using Step voltage for setting T_class at PSE and PD
  - Step voltage with IEEE802.3af operating range[1]
    - It may cause false PoEp PD triggering and massing up af PSE during its classification phase[2].
    - Increased accuracy requirements from V_class operating range[2]
      - Increase costs in PSE per port.
  - Sources of time error along the channel[1,2]
    - T_class operating range[1,2]
    - Increasing T_class gray area (margins)[2]
- All the above assumes:
  - IEEE802.3af Signature Detection for data or non-data pairs is not changed
  - Classification function is not depend on signature detection signals and timings.

Requirements Analysis for meeting the 802.3at Objectives

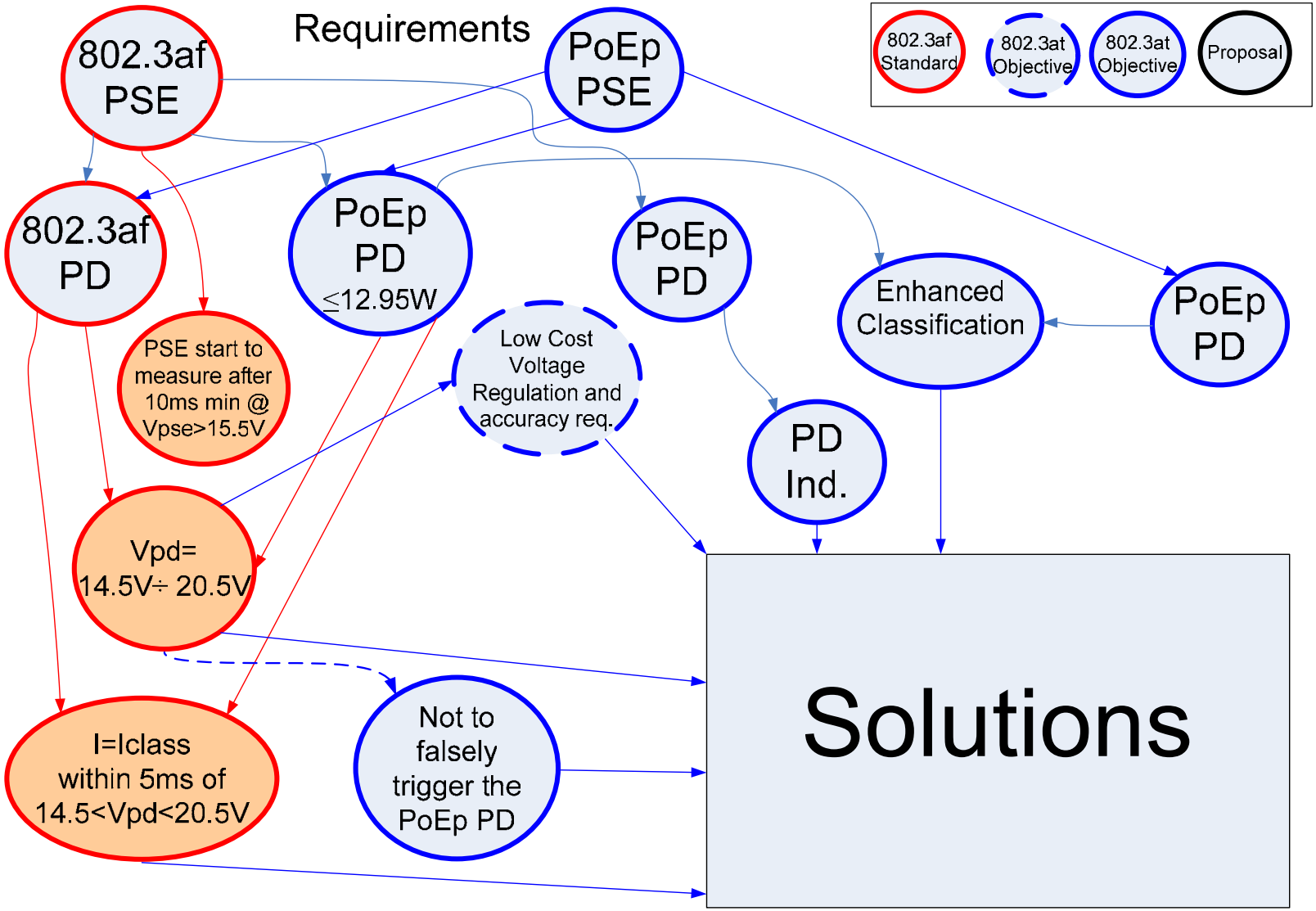


Requirements Analysis for meeting the 802.3at Objectives

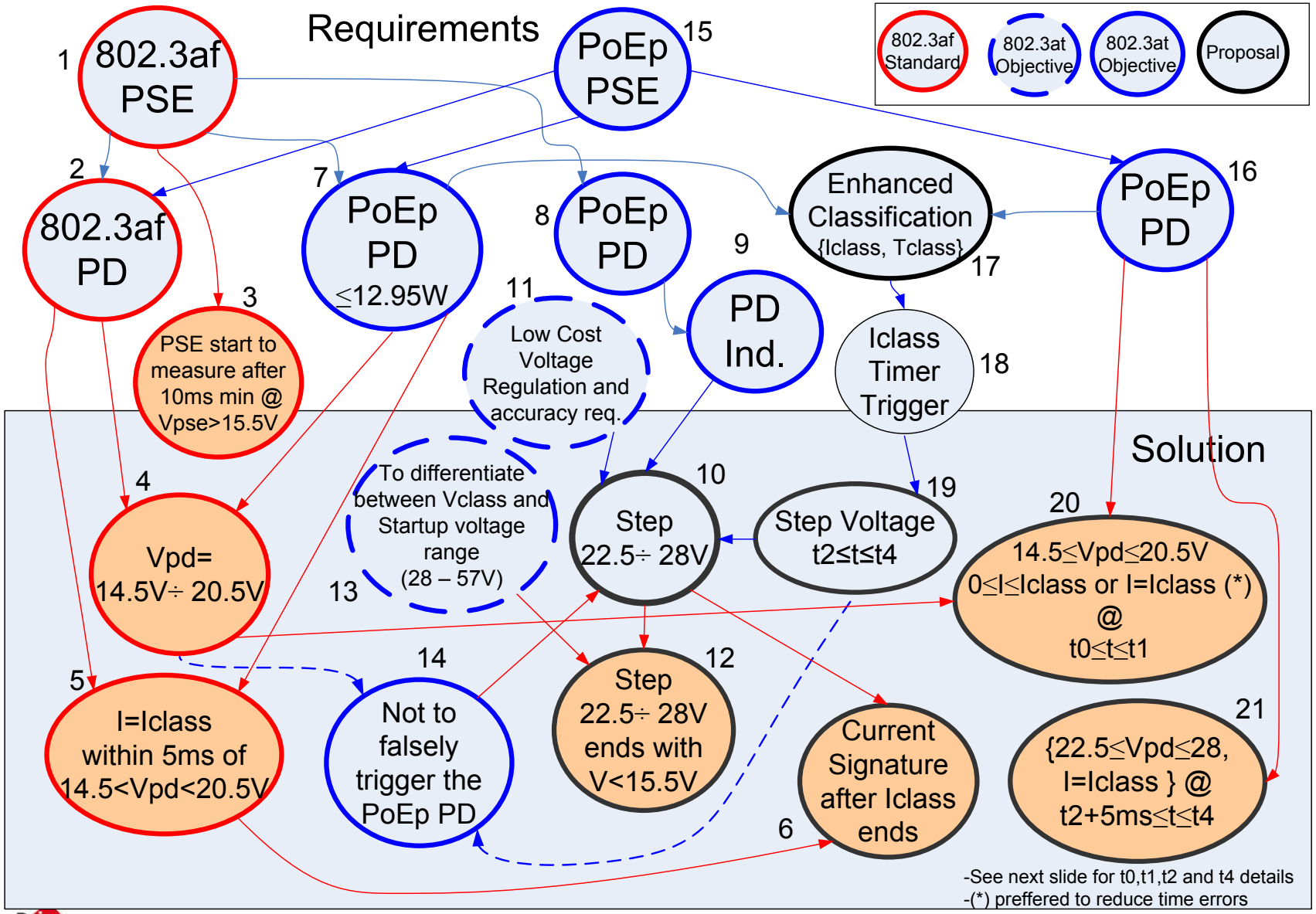


After simplifying.. by merging similar requirements.

Requirements Analysis for meeting the 802.3at Objectives



Requirements Analysis for meeting the 802.3at Objectives



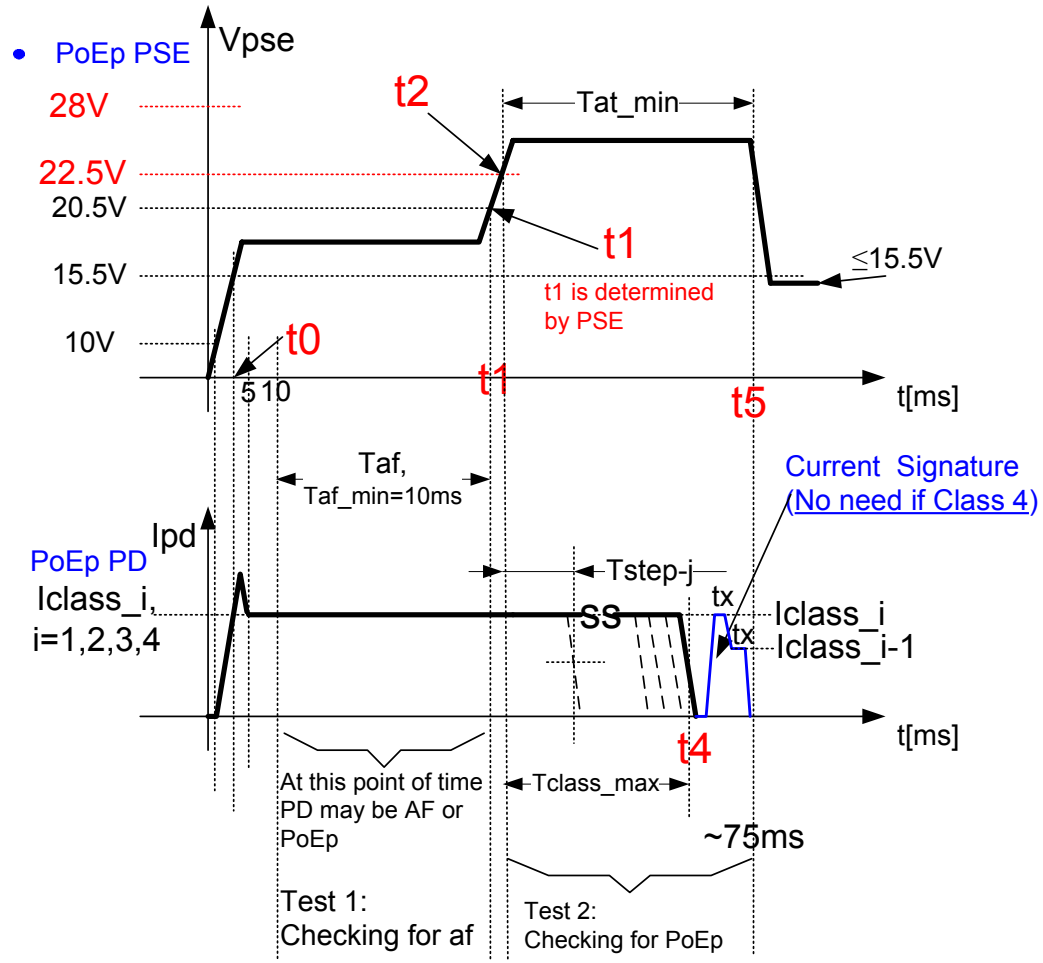
Extended Classification Table

- Example for Extended Classification Based on {Iclass,Tclass} combinations
  - Pmax =40W at the PD input (Example)
  - Sub-class distribution is non-linear

Tclass	t1	t2	t3	t4	t5	t6	t7	t8	t9	t > t9
I_class (802.3af)	Power Allocated [Watts]									
10mA	0.44	0.6	0.7	0.9	1.1	1.5	1.9	2.4	3.0	3.8
18.5mA	4.8	5.0	5.2	5.3	5.5	5.7	5.9	6.1	6.3	6.49
28mA	6.7	7.2	7.8	8.4	9.0	9.7	10.4	11.2	12.0	12.95
40mA	13.9	15.7	17.6	19.8	22.3	25.0	28.1	31.6	35.6	40.0

PoEp PSE vs PoEp PDs

All time points are with respect to t0.
Drawings are not to scale



-Tat_max=Max time for PoEp PSE for ending all PDs class measurements

-Tclass_max= max value of highest subclass time duration.

-Class_i,j= {I_class-i, Tclass-j}, j=number of subclasses

-Ta=5ms(current steady state time), Ta may be reduced .

-t1 is determined by PSE to some extent. It is limited by total classification duration minus Tat time. t1 min=10ms (IEEE802.3af)

Step 1:

PoEp PSE sets 802.3af class voltage levels for time duration Tat. Tat min=10ms.

Tat max determined by PSE.

Step 2:

When PoE PD voltage crosses 14.5V, Iclass is built and gets steady state within 5ms. PSE may start looking for af PDs only after 10ms from t0.

Step 3:

If no Iclass, then it is af PD. If I=Iclass then PSE steps the voltage to 22.5-28V range (Example) and check for PoE PD class. PoEp class is obtained by measuring Iclass and its duration. Class current duration, Tclass-j is measured from Vpse=22.5V point to the time I<Iclass-0.

Step 4:

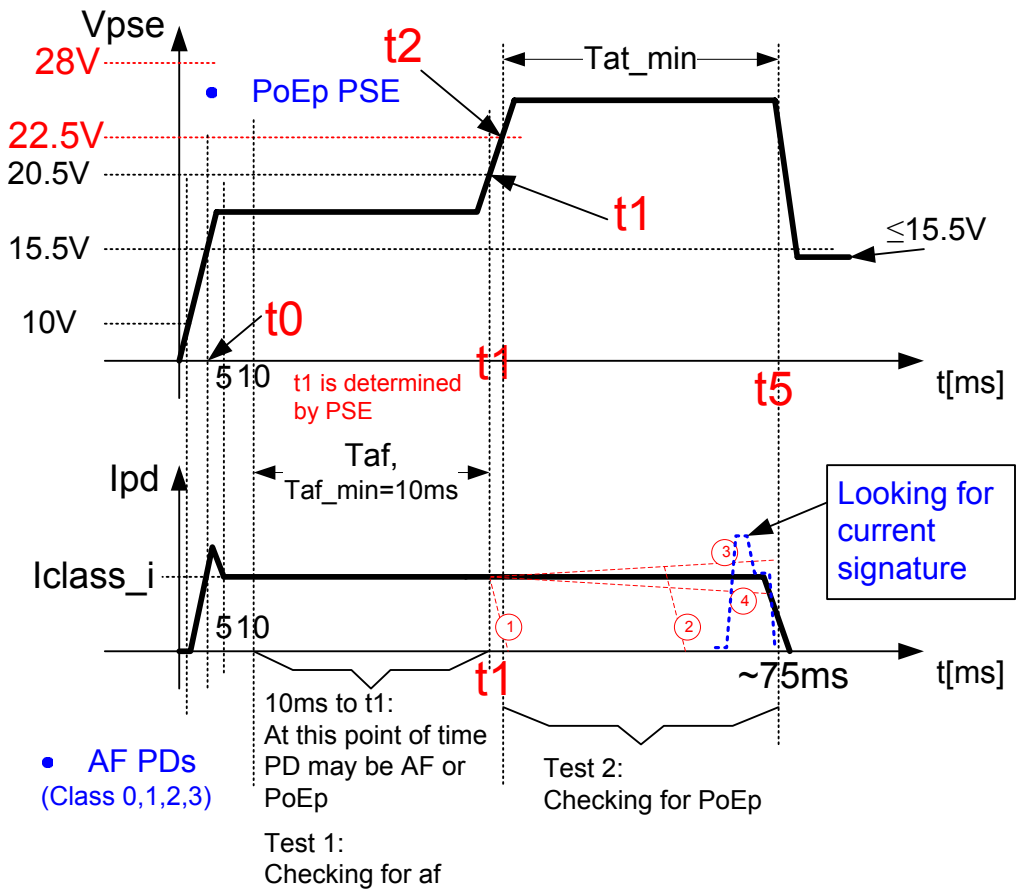
PSE checks for current signature as described.

If no current signature, it is 802.af PD.

See details next slide

PoEp PSE vs 802.3af PDs

All time points are with respect to t0.
Drawings are not to scale



-Tat_max=Max time for PoEp PSE for ending all PDs class measurements

-t1 is determined by PSE to some extent. It is limited by total classification duration minus Tat time. t1 min=10ms (IEEE802.3af)

Current Signature to differentiate between deterministic current stop/change in PoEp PDs to random current stop/change in 802.3af PDs when Vclass>20.5V.

Steps 1-4:

The same as in previous slide.

Why current signature?

-IEEE802.3af doesn't specify behavior for > 20.5V. Hence cases 1-4 may happen.

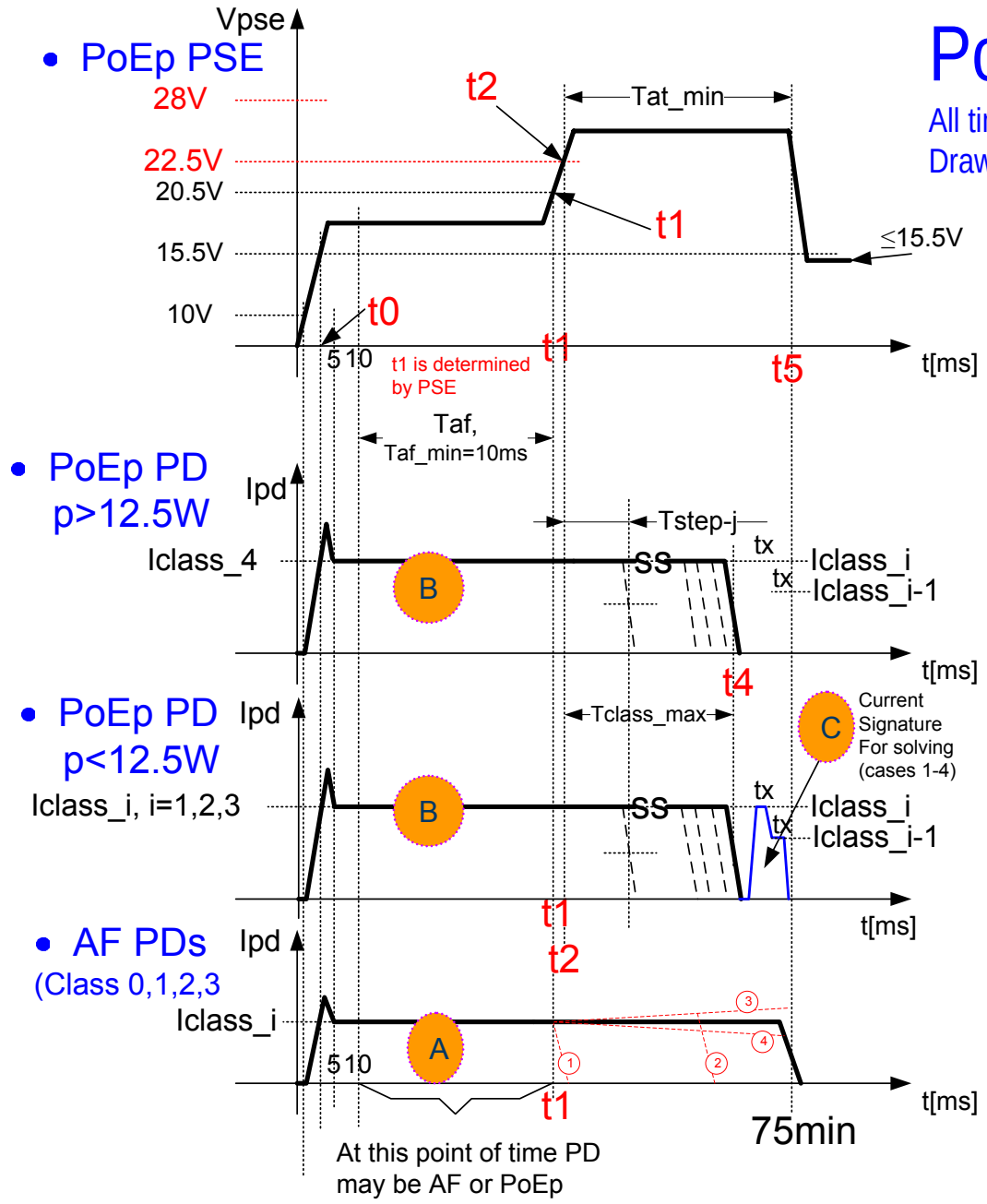
-If Iclass is maintained then it is af PD

-If Iclass is not maintained; by checking signature we know for sure that the change in current done by PoEp PD.

-Current signature is consist of two current levels Iclass_i and Iclas-i-1 which can be easily measured by the PSE for absolute reliability.

PoEp PSE vs all PDs

All time points are with respect to t0.
Drawings are not to scale



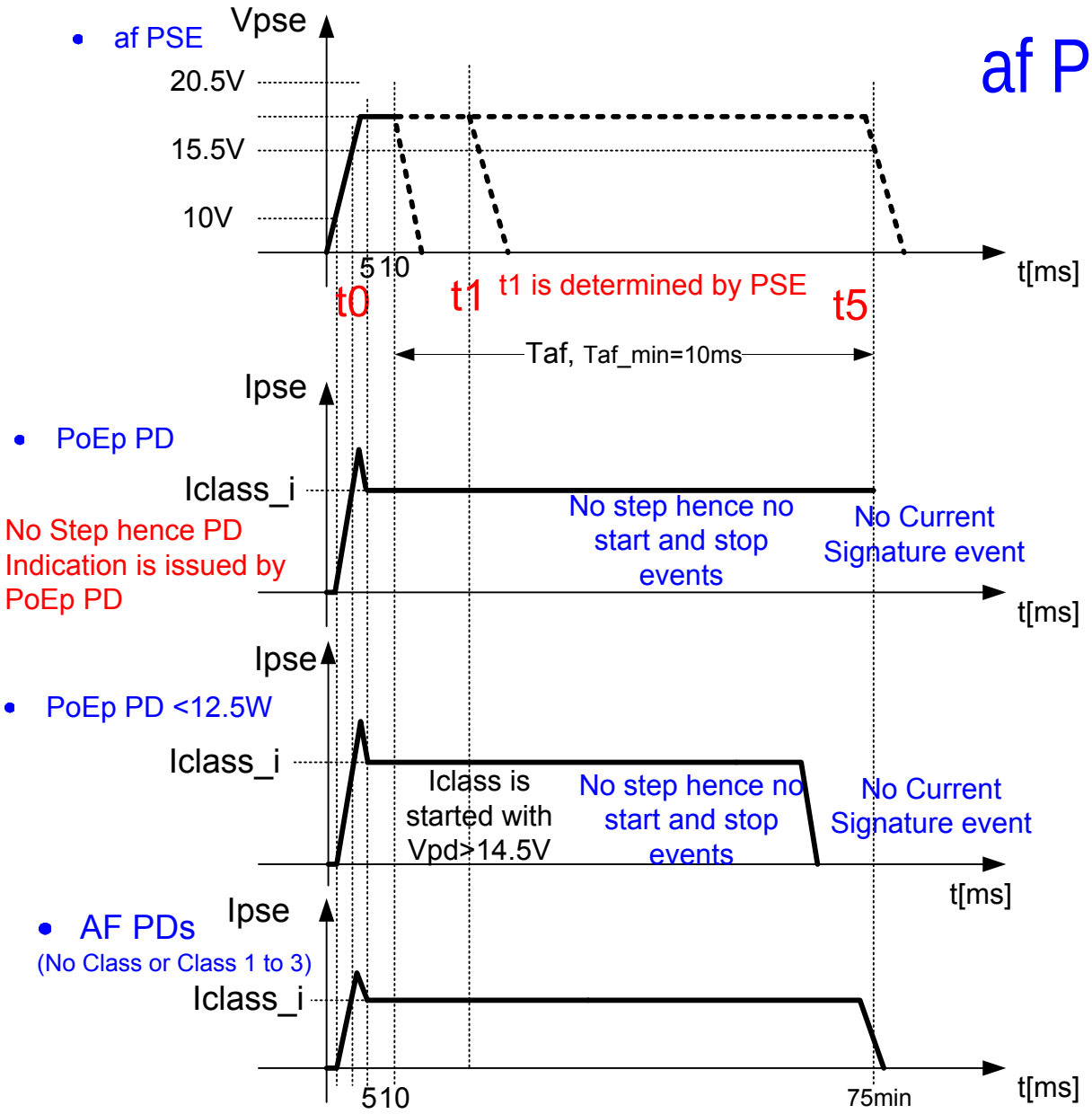
B — AF PSE May look for current right after 10ms. Therefore PoEp PD with <12.95W need to consume I_class within 5ms after Vpd>14.5V

A — Possible af PD behavior at Vpd>20.5V
1)AF PD shut off when Vpd>20.5V
2)AF PD shut off due thermal issues when Vpd>20.5V
3),4) AF PD I_class is not guaranteed by spec for Vpd>20.5V

C — Therefore PoEp PSE is checking classification for af PDs only within Taf_max time and looking for current signature after the end of T_class

af PSE vs all PDs

- af PSE



- PoEp PD

No Step hence PD Indication is issued by PoEp PD

- PoEp PD <12.5W
- AF PDs

(No Class or Class 1 to 3)

PoEp Enhanced Classification Algorithm

PSE	Test #1	Test #2	Test 3	PSE final tests Results
PSE Time Interval	Taf	Tat		
PSE Classification Voltage Range	15.5 to 20.5	2.5 to 28 (Example)	Current Signature	
PD Ipd (Iclass,Tclass) and Current Signature	Iclass-i, **i=0**	Ipd<5mA→No Class No need for Test2	No need	802.3af PD, Class-0
	Iclass-i, **i=1,2,3**	Iclass = Anything	Fail	802.3af
	Iclass-i, **i=1,2,3**	Iclass-i, Tclass-j	PASS	PoEp PD
	Iclass-i, **i=4**	Iclass-i, Tclass-j	No need	PoEp PD[5]

- (5) Class 4 is not permitted in IEEE802.3af PD

Timing details

- Taf_max= t1-t0-10ms=Max time for PoEp PSE for ending AF PD class measurement
- Tat_max=t5-t2=Max time for PoEp PSE for ending PoEp PDs class measurements
- Tclass_max=t4-t2= max value of highest subclass time duration.
- Tclass-j=Ta+Tstep-j

  Tstep-j= j*Tstep*(1+k)^(j-1), j=1,2…m, k is optional, k<1 (e.g k=0.1)
- Class_i,j= {I_class-i, Tclass-j}, j=number of subclasses
- Ta=5ms(current steady state time, Ta may be reduced .
- max current steady state < 5ms (Similar to IEEE802.3af)
- t1 is determined by PSE to some extent. It is limited by total classification duration minus Tat time. t1 min=10ms (IEEE802.3af)

Energy Dissipation

	Vclass_max						
	802.3af	802.3at	Taf [s]	Tat [s]	Iclass_max [A]	Energy [Joule]	Notes
IEEE802.3af system	20.500	20.500	0.075	0.000	0.030	0.046	
PoEp PD option 1	20.500	28.000	0.030	0.045	0.044	0.083	1,2
PoEp PD option 2	20.500	28.000	0.000	0.045	0.044	0.055	1,3
PoEp PD option 3	20.500	20.500	0.030	0.045	0.044	0.068	1,5
PoEPp PD, p<12.95W	20.500	28.000	0.030	0.030	0.030	0.044	1,2,3
AF PD	20.500	28.000	0.030	0.045	0.030	0.056	1

Notes:

1. Energy levels can be further reduced by optimizing voltage levels and timings
2. Option 1 energy can be reduce by forcing zero current at Tat region until few ms prior too t2.
3. Option 2 allow reducing energy by measuring the Tclass start point by the current and not voltage. In this case during the Tat time the current can be zero.
4. Energy dissipation can be managed by PSE or PD by using shorter classification time measurements during Taf and Tat and by limiting the time between convective classification cycles.
5. See option 3 details in Annex A. Will be elaborated more at next meeting.

More Inputs

- AF PSE:
- May look for current right after 10ms. Therefore PoEp PD with <12.95W need to consume I_class within 5ms after VpD>14.5V.
- PoEp PD with higher power then 12.95W may use any current level from zero to Iclass with the cost of few ms more for the classification duration (see option 1 and 2 in the previous slide)

  In the current presentation we focused on the simple implementation of having current right after Vclass>14.5V in order to achieve faster steady state current hence reducing classification time.

- Possible AF PD behavior at Vpd>20.5V
  - 1)AF PD shut off when Vpd>20.5V
  - 2)AF PD shut off due thermal issues when Vpd>20.5V
  - 3),4) AF PD I_class is not guaranteed by spec for Vpd>20.5V

  Therefore PoEp PSE is checking classification for af PDs only within Taf_max time and looking for current signature after the end of T_class

More Inputs

- Why not to use the step signal at the beginning of the classification phase with voltage above 20.5V and returning to voltage range 15.5 – 20.5?
- Answer:
  - In IEEE802.3af Iclass is not defined above 20.5V
  - IEEE802.3af PDs may not allow V_class over voltage and then immediate recovery. It may thermally protected for unknown time.

PD indication concept

If Vpd

a) is {0V, (14.5-20.5V, 10ms min)} and

b) {22.5-28V ,10ms min} and

c) Vclass drops to <14.5V

Then it is PoEp PSE

else

It is not PoEp PSE

Tclass Timing, Time errors etc.

- All the following aspects
  - Tclass timings
  - Time error sources
  - Other {Iclass, Tclass} data

- Are similar to the concerns and their solutions as discussed in previous presentation[1,2]

Summary

- Enhanced classification that meets the IEEE802.3at objectives has been presented.
  - No potential false PoEp PD indication
  - No potential false classification current change when connected to af PSE
- It is cost effective and robust.
  - No need for accurate and well regulated Classification voltage
  - No need for ac signaling on top of the DC voltage.
- Need to optimize timings and voltages if our group finds that the proposal meets our objectives and worth further work.

Recommendations for IEEE802.3at Standard.

PD side

- Extended classification (including Class 4) in 802.3at PD should be mandatory and not optional (as in IEEE802.3af classification.)
- The enhanced classification table may be divided to two parts[6]:
  - Part a: power classes that can work with either 44V or 51V.
  - Part b: power classes that can work only with 51V minimum at the PSE.
  - No additional hardware required in the PD or PSE. It is just additional information field that may be contained in the informative section.
  - Helps to the PSE to whether to power the PD if PSE equipped with 44V–57V power supply range.

Adding new data field to the extended classification table.

- Defines which classes may work with 44V-57 range and which need 51V-57V to supply the PD load.
- Example

Tclass	t1	t2	t3	t4	t5	t6	t7	t8	t9	t > t9
I_class (802.3af)	Power Allocated [Watts]									
10mA	0.44	0.6	0.7	0.9	1.1	1.5	1.9	2.4	3.0	3.8
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40mA	13.9	15.7	17.6	19.8	22.3	25.0	28.1	31.6	35.6	40.0
Ipse max [A]	Vpse_min									
0.35	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
0.35	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
0.35	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
0.44	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	51.0	51.0

Recommendations for IEEE802.3at Standard.

- PSE side
  - IEEE802.3at PSE that uses 44V-57V operating voltage range should be able to power 802.3at-complaint PD's with classes of Part (a)
  - IEEE802.3at supplies power only if capable (Like we do today in IEEE802.3af)
  - IEEE802.3af PSE classification including class 4 should be mandatory in IEEE802.3at PSE.
    - To simplify differentiation between 802.3af PD and PoEp PD.
  - IEEE802.3at PSE extended classification is optional.
    - Like classification is currently optional in 802.3af

Questions and Discussion

References

1. An Extended Classification Protocol for PoE Plus (Revised) Steve Robbins, July 2005
2. Recommended guidelines for enhanced classification concepts. Yair Darshan Nashua, NH September 2005
3. IEEE802.3at list of objectives:
   http://www.ieee802.org/3/poep_study/802_3_poep_objectives.pdf
4. Cost effective detection and classification, Mat Landry, July 2005
5. IEEE802.3af clause 33.3.4, Table 33-10, the note regarding compliancy of IEEE802.3af with Class 4.
6. Technical and market considerations regarding PoEp output voltage range, Vancouver BC, November 2005
   Arkadiy Peker , Daniel Feldman, Yair Darshan

Annex A- Proposal #2.

- Similar to proposal #1 with lower classification voltages.