IEEE802.3at Study Group

Recommended guidelines for enhanced classification concepts

Nashua, NH September 2005

Yair Darshan/ PowerDsine

Objectives

- Purpose of the presentation
  - To generate a list of guidelines which will help us to establish enhanced classification concept that meets the following data sources and requirements:
  - IEEE802.3at objectives
  - Practical limitations
    - Implementation limitations due too system requirements, cost, complexity and different system architectures being used in the market

Terminology

- Pmin: PD minimum port power.
- Pmax: PD max port power
- Pport_avg: Average port power in a multi-port environment
- PSu: Power Supply utilization factor which is the ratio between the actual power taken to the allocated power based on the classification information.
- Class_step: the minimum class resolution required to allow meeting the desired PSu_avg
- β: The ratio between Class_step/Pport_avg that ensures meeting the PSu_avg target.
- PoEp: IEEE802.3at higher power PoE
- LPS=Limited Power Source per EN60950 definition

Relevant IEEE802.3at Objectives[1] for enhanced classification concepts

- (1) Extension of power classification (Objective 9)

- (2) Backward and Forward compatibility (Objectives 4, 13 and 14)
  - PoEp PSE can identify AF PD
  - PoEp PSE can identify PoEp PD
  - PoEp PDs with AF power levels will work with legacy 802.3af PSEs

- (3) PSE type identification (Objective 7 and 14)
  - PoEp PD which requires PoEp PSE, indicate if connected to legacy 802.3af PSE. (May be addressed by other functions such as detection or startup)

- (4) To support maximum power within practical limits (Objective 5)

How Objectives affect potential concepts

- (1) Extension of power classification (Objective 9)
- IEEE802.3af has 4 classes based on current level information
- Many more classes required for improving power management.
  - Analysis shows[5,6] that the number of classes that are required for efficient power management (pending on PSu_avg, class_step, Pmin, Pmax=68W[7], Pport_avg and data format from the PD {Current, Time}[2] or Time only) are far greater than supplied by 802.3af.
  - Looking at only single domain (current) is not enough. Additional domain is required (time or time equivalents) to generate more classes.
    - In the linear[4] class method: ~ 30 to 70 classes
    - In the logarithmic[4,5] class method: 13 to 30 classes
    - In combined[4,5] Log-Lin methods: 30 to 40. *(Recommended; PSu_avg is maintained at higher power classes too)*

How Objectives affect potential concepts

- (2) Backward and Forward compatibility (Objectives 4, 13 and 14)
  - PoEp PSE can identify AF PD
  - PoEp PDs with AF power levels will work with 802.3af PSEs
  - For PoEp PD:Keeping at least the same IEEE802.3af PD current levels and timings (5ms, Class 0-4 current levels)
  - 802.3af classes are subset of enhanced classification classes
  - For PoEp PSE: Keeping the same IEEE802.3af PSE class voltage range, and timings (10mS, 15.5V-20.5V)

How Objectives affect potential concepts

– (2) cont.:PoEp PSE can identify PoEp PD

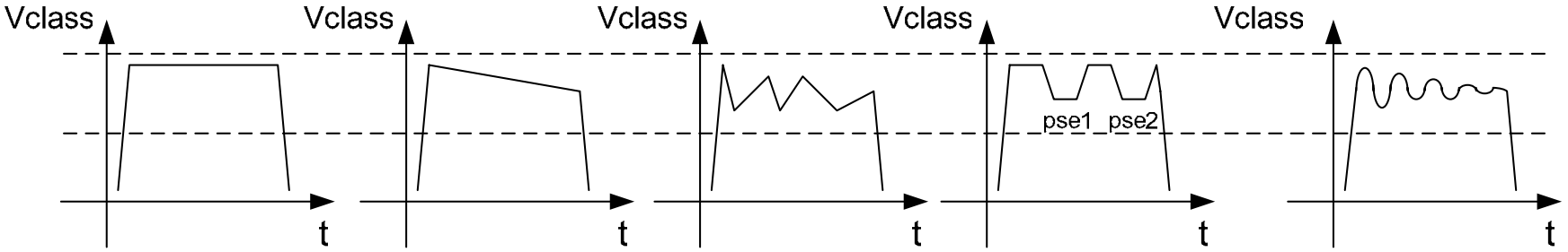
– We need to ensure (~100%) that the operation of PoEp PD or 802.3af PSEs will not be affected by Vclass load regulation response of IEEE802.3af PSEs during multi-ports operation. Otherwise objectives 4, 13 and 14 are impaired.

– Arguments such:

  - Low probability to happen *(true if error free filters and protocol are used. Cost?)*
  - Such scenario was not observed etc. *(The standard allows it so it will and actually it was observed)*

– Are not relevant from standard point of view if it was permitted previously.

  - It will cause some of the PD's (false triggering) or some of the PSE's (shortening Iclass of AF PDs) to fail in compliance tests or in the field while they are OK per IEEE802.3af specifications.



IEEE802.3af: Possible Load response of Vclass regulator in multi-port environment

How Objectives affect potential concepts

- (3) PSE type identification (Objective 7 and 14)
  - PoEp PD which requires PoEp PSE, indicate if connected to legacy 802.3af PSE. (May be addressed by other functions such as detection or startup)

- This requirement is relevant for enhanced classification protocol as long as:
  - Only the PSE has this information (PSE type information)
  - The target is to use classification function, as the PD indication per objective 7 and *detection function in PoEp is compatible with legacy PSE detection.*
    - Otherwise we will not get to classification phase.
  - To allow indication prior power up trials.
    - Although implementing indication during power up is acceptable too.

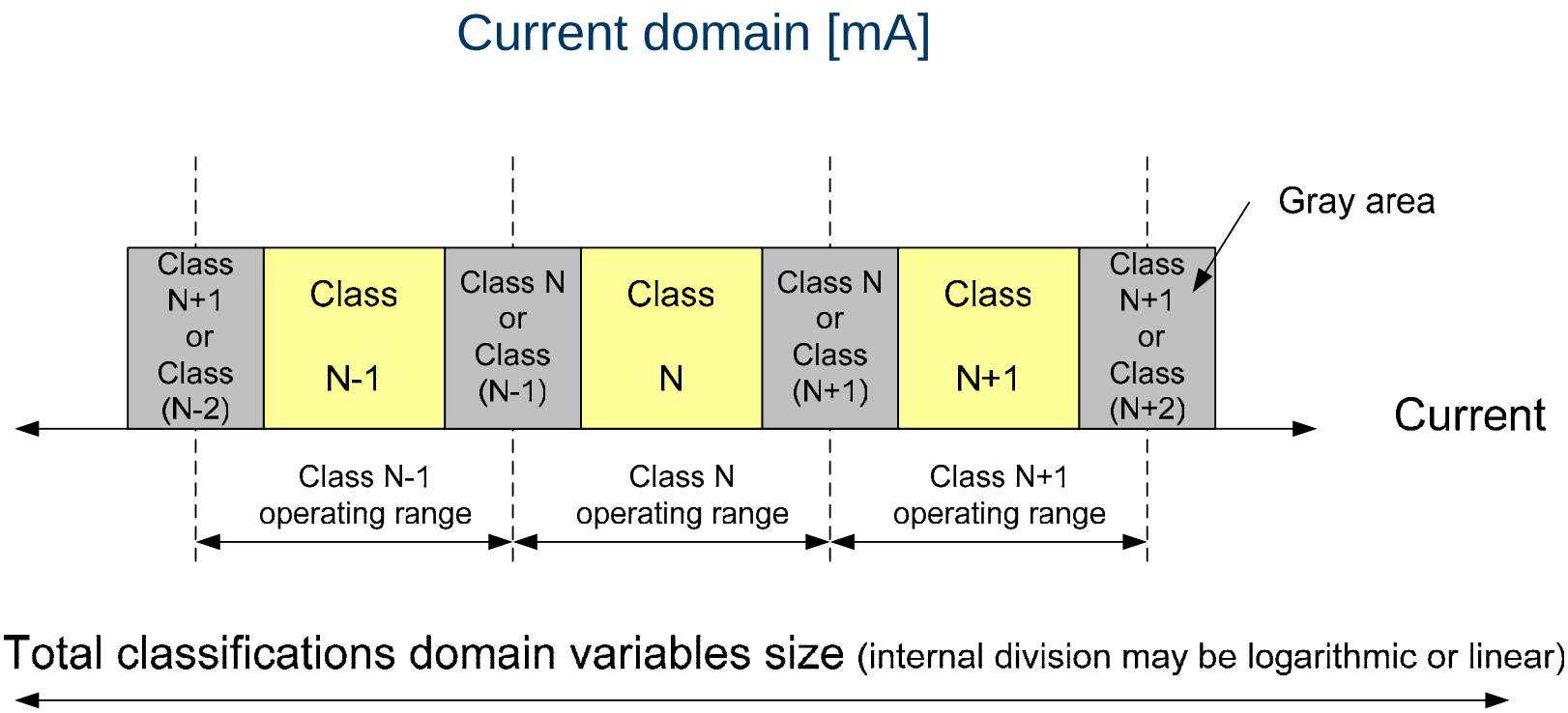
How Objectives affect potential concepts

- (4) To support maximum power within practical limits (Objective 5)
  - Meeting objective 9 (Extending classification) and setting practical limits[7] that meets Objective 5.
  - Increased number of classes for better resolution and supporting Pmax
  - What is the value of Pmax[7]
    - Pmax<100W (to meet LPS safety requirements)
    - Pmax< 68W (per TIA/EIA; Pmax_PD=2*840mA*51V-0.84^2*12.5*2= 68W)
    - Pmax< 65 (to keep PD/PSE efficiency >>TBD% , keep low cabling loss)
    - Pmax< 55W (to support overload – 15% margin)
    - Pmax< TBD1 (If connectors and/or cabling will be the limiting factors
    - Pmax <TBD2 (If data transformer became a limiting factor, heat, size)
    - Pmax< TBD3 (Design margin)
  - Hence max power can be assumed to be 68W (at the PD)
    - Max practical power is lower (below 55W) per the above margins required.
  - For future use (better cabling or other TBD developments) we should consider keeping unused optional classification space
    - 100W is the abs max per the safety standards definitions for LPS

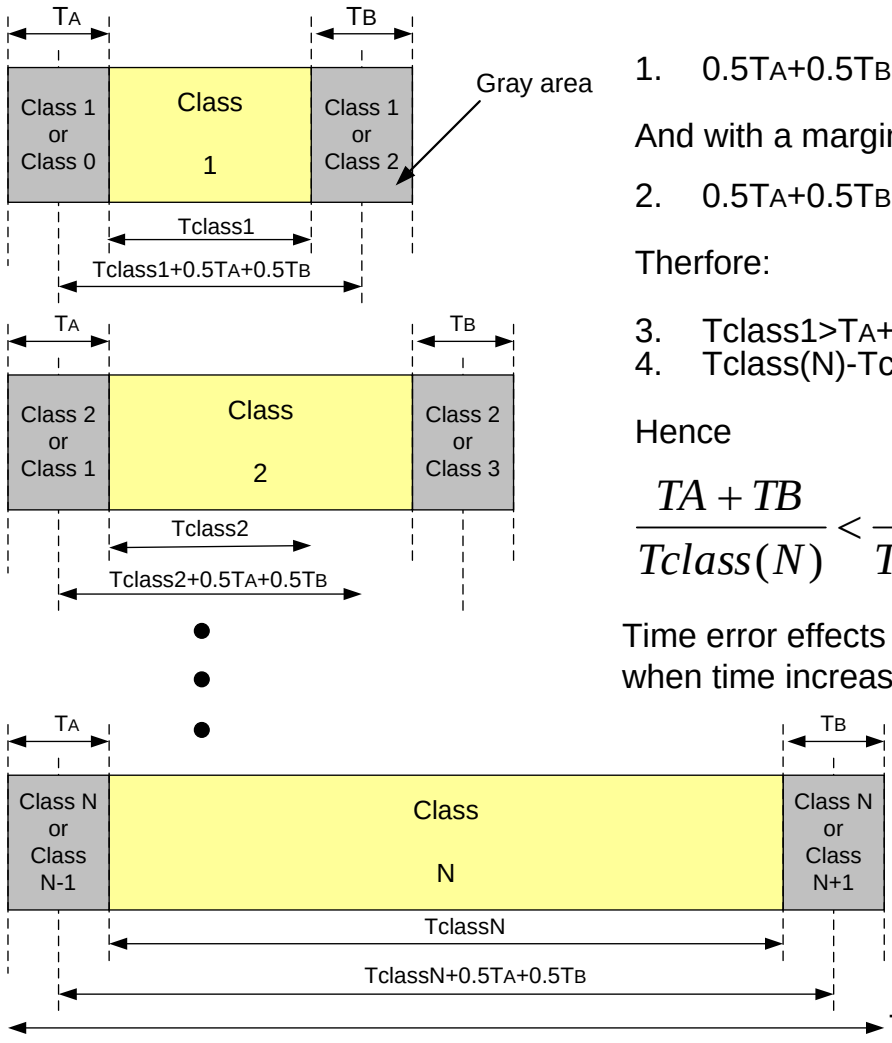
Practical limitations – Accuracy, Resolution

- Current and voltage measurements
  - Cost effective accuracies: ~±10 to 15%
- Power measurements
  - Cost effective accuracies: ~±21% to 33% (to allow OVLD per Class)
  - It means that there is no advantage of Class(n)/Class(n-1)<21% - 33%
- Time/Frequency measurements
  - Internal clocks accuracy: ~±10%
  - Sampling rates at the port: 10 -100's KHz range
    - Stand alone devices
  - Sampling rates at the port: 1K-10K range
    - External managers at the port
- All the above affect the:
  - class current level or time/frequency parameters
  - The gray area size (increased) for ensuring cost effective error free measurements
  - Error sources

Practical limitations - Accuracy, Resolution



Practical limitations - Accuracy, Resolution



1. $0.5T_A+0.5T_B \ll Tclass1$

And with a margin of 100% min:

2. $0.5T_A+0.5T_B < 0.5 * Tclass1$

Therfore:

3. $Tclass1 > T_A+T_B$
4. $Tclass(N)-Tclass(N-1) > 0.5T_A+0.5T_B$

Hence

$$\frac{TA+TB}{Tclass(N)} < \frac{TA+TB}{Tclass(N-1)} < \ldots\ldots < \frac{TA+TB}{Tclass(1)}$$

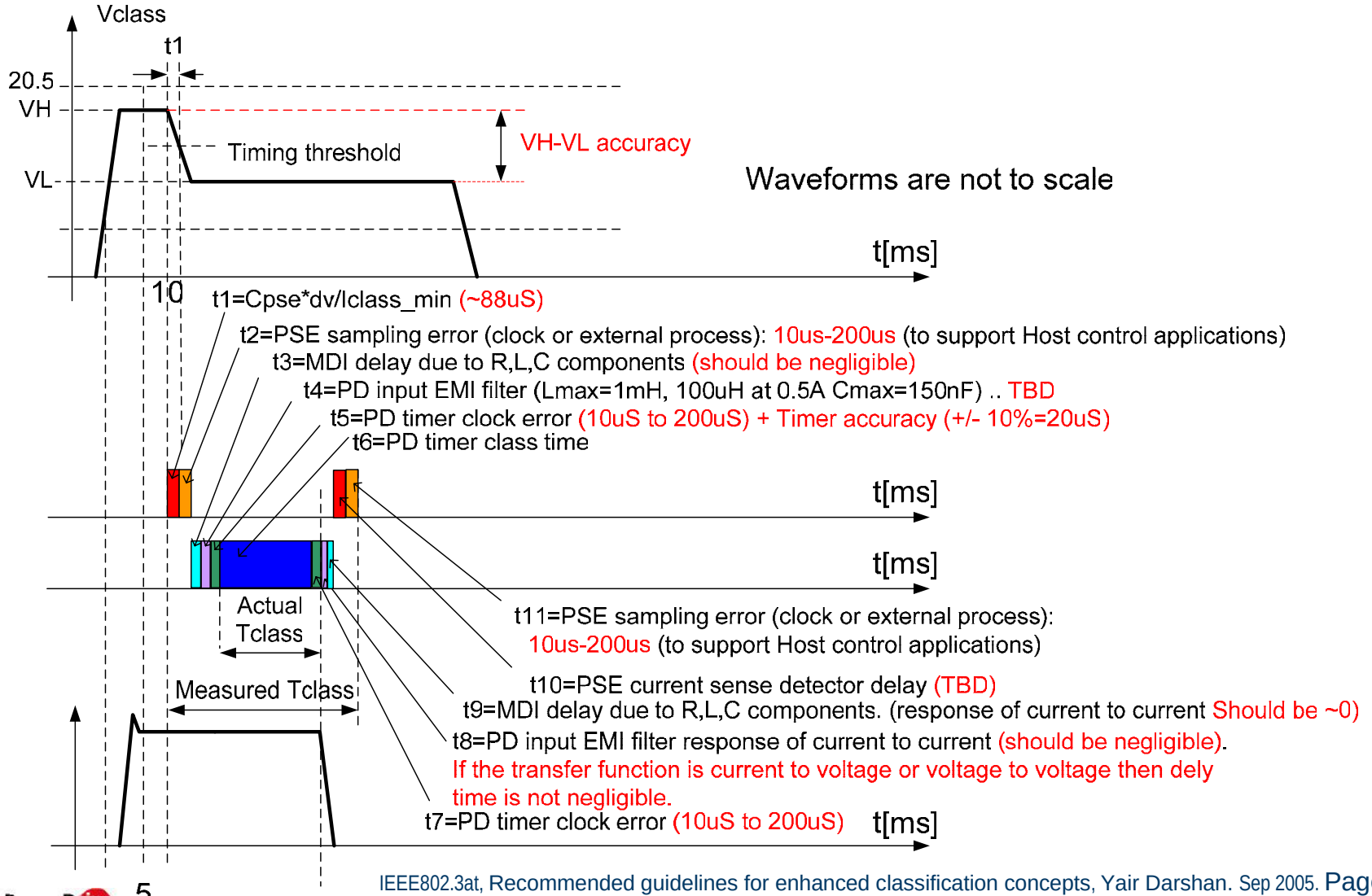
Time error effects decreased
when time increased (higher classes)

- Time domain

Total classifications domain variables size (internal division may be logarithmic or linear)

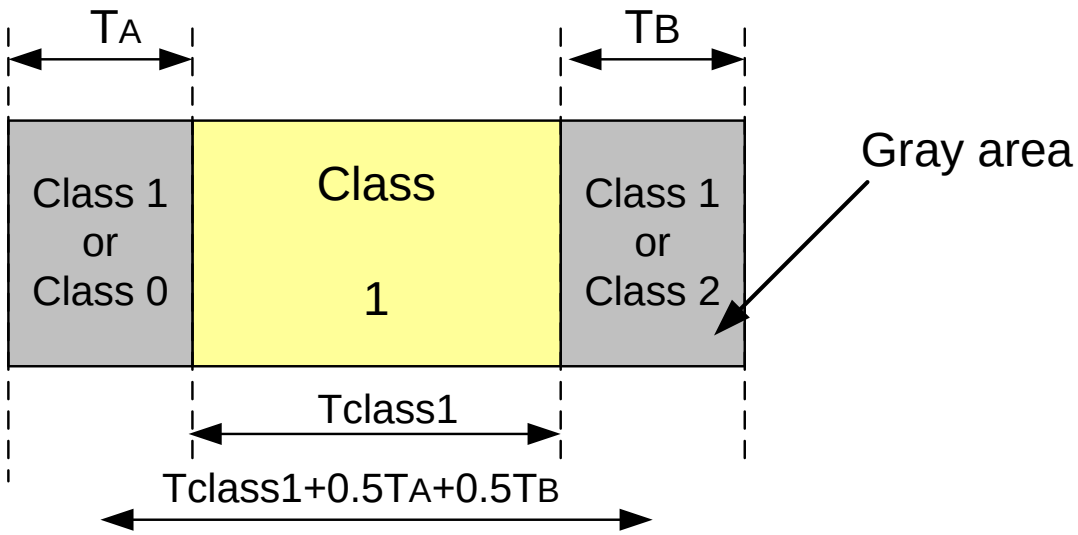
Practical limitations – Sum off all errors= “Gray Area”

- Additional error sources when a time data is determined by both PSE and PD. Reviewing ideas presented at July meeting by 2,3,4.



Practical limitations - Accuracy, Resolution

- Recommended timing ranges:
  - Time information, Tclass: should meet Tclass >> $0.5T_A+0.5T_B$.
    - Or with 100% margin: $0.5T_A+0.5T_B$ should be < 0.5Tclass
    - Otherwise, Tclass may not be error free.
  - Recommended gray area (accumulated time error + 50% margin) TA+TB=~1.5ms
  - *Numbers are needed to be simulated and verified for having margins not to high (cost) or too low (errors)*
  - Since $0.5T_A+0.5T_B$ < 0.5Tclass ➔Tclass_min>3ms.
  - Tclass(N)-Tclass(N-1)> $0.5T_A+0.5T_B$ ➔ Tclass(N)-Tclass(N-1)> 1.5mS



Practical limitations – Vclass operating range

- IEEE802.3af Vclass operating range: 15.5-20.5V
  - 5V difference forms 32% margin, allows economically feasible regulators (+/- 16% accuracy)

- PoEp PSEs:
- If step voltage^2 is used as part of the enhanced classification it adds higher accuracy requirements which is difficult to achieve at low cost.
- Example:
- For a DC value of 18V ± 2.5V:
- Adding step of 1V, force ~ 5% accuracy (±2.5%) between the upper range of the class voltage to the step voltage peak which is not cost effective for the PoE PSE.

- More work is needed to keep the same accuracy requirements as in the 802.3af to allow cost effective solutions.

Practical limitations – power dissipation

- IEEE802.3af worst case designs:

- PD side: ~20.5Vx30mAx75ms=~0.615W x 75ms minimum
  - Class 4 , 44mA was not actually used.
- PSE side: ~20.5Vx44mAx75ms=~0.9W x 10mS min, 75ms maximum
  = ~0.9Wx (~40ms) average.

- It is recommended that enhanced classification will not requires *significantly* more then the above values.
  - Not to add additional current class beyond class 4 (44mA)
  - Not to increase classification average time (~40ms @ 44mA)

Summary 1/2

- Recommendation for enhanced classification concepts design guidelines:

- Need to meet:
  - 802.3at objectives as presented
  - IEEE802.3af classification voltage and current including class 4 should be supported in both in PSE and PD
  - Operation of PoEp should not based on Vclass amplitude changes.
  - Unless:
    - 100% guarantee (and cost effective) of no violation of objective 4
      - 802.3af PSE will not falsely detected as PoEp PSE
    - Accuracy requirements of Vclass regulator is not harden
  - Enhanced classification should use passive concepts as much as possible for reducing cost and complexity.

Summary 2/2

- Recommendation for enhanced classification concepts design guidelines:
  - Time based data should be in the millisecond range; at least ~3ms for the first lower class)
    - Gray area=Accumulation of round loop time errors should be ~1.5ms
    - TclassN-TclassN-1> 1.5mS
    - *Numbers need to be simulated or tested (in PSE-PD systems) to verify that margins are not to high (cost) or too low (errors)*
  - PD indication may be solved by classification function however it is not a must. Other alternatives are acceptable too.
  - Optional classes should be reserved for future use up to 55W-68W
  - It is recommended to use combined[4,5] log / lin scale in order to have higher resolution (maintaining the desired PSu_avg) in higher classes compared to only logarithmic scale.

What next

- The following topics needs further investigation:
  - Checking if changing Rsig=TBD for differentiating between PoEp PD and 802.3af simplifies enhanced classification concepts
  - Checking the added complexity to PD indication objective and enhanced classification concepts for supporting 2P MP PDs.

Questions and Discussion

- ?

References

- 1. IEEE802.3at list of objectives: http://www.ieee802.org/3/poep_study/802_3_poep_objectives.pdf
- 2. An Extended Classification Protocol for PoE Plus (Revised) Steve Robbins, July 2005
- 3. Cost effective detection and classification, Mat Landry, July 2005
- 4. 802.3 PoEPlus Classification, Derek Koonce, July 2005
- 5. Classification Resolution Analysis Preliminary Analysis – Part A Darshan Yair San Francisco, June 2005
- 6 Classification Resolution Analysis Preliminary Analysis – Part A and B Darshan Yair Nashua, September 2005
- 7. Maximum Power - System considerations, Yair Darshan, Nashua, NH September 2005