IEEE802.3poep Study Group
How Power Management reduce system costs

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Yair Darshan
PowerDsine

Agenda

- Power Management and IEEE802.3af
- What is Power Management in PoE system
- Means to implement Power Management
- Power Management vs PoE system cost
- Summary and conclusions

Power Management (PM) and IEEE802.3af

- IEE802.3af specifies the requirements at the port level such as detection, classification etc.
- IEEE802.3af doesn't support system level requirements and they are considered implementation specific such as Power Management. (may be some exceptions for register bit mapping etc.)
- The 802.3af standard suggests to use the classification information for improving system power managements abilities. (See 33.2.7 and 33.3.4)
- The PoEp is following the same concepts above

What is Power Management in PoE system

- The ability to
  - Deliver/Limit/Stop power to the port when needed
  - Manage system power budget to efficiently utilize its resources
  - Allocating power per load needs

Means to implement Power Management

- Deliver/Limit/Stop power to the port when needed
  - Done by meeting IEEE802.3af requirements – Detection, Startup, on going protection circuits, Steady state requirements
- Supply power according to priority (optional)
  - Implementation specific – affects overall system availability and reliability

- For the purpose of evaluating the effect of PM on PoE system cost let's address only the following functions:
  - Manage system power budget to efficiently utilize its resources
  - Allocating power per load needs
    - Classification of PD power as defined by IEEE802.3af

Power Management vs PoE system cost

- Case 1: PoE without power management
  - Initial conditions and assumptions:
  - PSE doesn't know how much power PD needs
  - Therefore PSE allocates max power, Pmax
  - Hence PSE PS max capacity is:

$$PS_{NPM} = N \cdot P\max$$

N = number of ports in the PoE system

Power Management vs PoE system cost

- Case 2: PoE with power management - Example
  - Initial conditions and assumptions:
  - PSE knows PD power needs by performing classification function.
  - Lets assume 4 class levels, 0.25P_{MAX}, 0. 5P_{MAX}, 0.75P_{MAX} and P_{MAX}.
  - Lets assume that the probability that a PD with Class 1 to 4 will be connected to the system is respectively p1, p2, p3 and p4. sum of pi=1.

$$\text{Hence the average power per port is} = Pport_{avg} = \sum_{1}^{4} p_i \cdot class_i$$

  - Now we need to know p1…p4. Lets assume equal distribution..p1=p2=p3=p4=0.25
  - Therefore Pport_avg= 0.25x0.25P_{MAX}+0.25x0.5P_{MAX}+0.25x0.75P_{MAX}+0.25xP_{MAX}=0.625xP_{MAX}
    - Hence PSE PS max capacity =PS_{PM} = Nx 0.625xP_{MAX} [Watts]

Power Management vs PoE system cost

- PoE PS cost reduction with PM

$$\frac{\text{PSE PS with PM}}{\text{PSE PS without PM}} = \frac{\text{N} \cdot 0.625 \cdot P\,\text{max}}{\text{N} \cdot P\,\text{max}} = 0.625 = 62.5\%$$

- 37.5% cost reduction with PM for uniform distribution
- In reality distribution is not uniform. Actually probability is up up when power level is going up until some point and than behavior is reversed.

- Average power per port is <=50% in most applications environments

Power Management vs PoE system cost

- The general case:

$$\frac{\text{PSE PS with PM}}{\text{PSE PS without PM}} = \frac{\mathrm{N} \cdot \sum_{i=1}^{m} p_i \cdot \mathrm{Class_i}}{\mathrm{N} \cdot Class_m}$$

$$\sum_{i=1}^{m} p_i = 1$$

$$PSE\_PS\_Capability\_with\_PM = \mathrm{N} \cdot \sum_{i=1}^{m} p_i \cdot \mathrm{Class_i}$$

$$PSE\_PS\_Capability\_without\_PM = \mathrm{N} \cdot Class_m$$

- m is the class with max power

Economical Feasibility- Effects on PSE side

- PSE power supply
- In average, no change in $/W cost.
- Increase of 0% to 50% in ABS cost pending of the power management concept being used.
  - Increase of 0% per simplest PM example scheme
- Heat due to increase in power delivered.
- Increase of 0% to 50% (out of ~20% of output power=80% PS efficiency)
  - power management method being used (can be 0% with power management and/or assigning specific ports to PoEp)
  - Power supply efficiency
  - Room size and ventilation

PoEp vs IEEE802.3af - Example 1

- PSE PS power has fixed max value = e.g. Power level used in a IEEE802.3af system
- N ports of IEEE802.3AF power
- M ports of PoEp power
- Assuming K[%] of the ports are supporting max power per port
- Total power=K(N*15.4W+M*30W)=Constant
- Total increase in PSE PS power=0
- Total increase in PSE PS cost=0
- Zero increase in heat and cost of PSE PS in the above example

PoEp vs IEEE802.3af - Example 2

- PSE PS power capability = Support up to 50% of the ports with max power.
- 50% of the ports are IEEE802.3af, 15.4W
- 50% of the ports are PoEp ports, 30W
- Total PoEp PS capability: 0.5*0.5*N*15.4W+0.5*0.5N*30W=0.5*0.5*15.4(1+1.948)*N
- Total IEEE802.af: 0.5*N*15.4
- PoEp/IEEE802.3af = 0.5*(1+1.948)~1.5 ➔ +50%
- Total increase in PSE PS power=50%
- Total increase in PSE PS cost=50%
- Total increase in heat in PSE PS=50%
  - (e.g. additional 20W over existing 40W for a 300W power supply)

Summary and conclusions

- Power Management reduces PoE/p system costs
  - Analytical demonstration supplied
  - Zero cost increase of PoEp compared to IEEE802.3af power management scheme was presented
  - 50% cost increase for 100% power increase power management scheme was presented

- As presented in Economical Feasibility:
  - PoEp / IEEE802.3af =0% to 50% cost increase in ABS cost pending of the power management concept being used.