White Paper

Demystifying PoE

excel without compromise.

It's a welcome bonus of Ethernet and structured cabling, but as the demands for Power over Ethernet (PoE) grow, is this once preferred solution about to run out of control? Paul Cave, Technical Manager for Mayflex, investigates some of the realities of PoE and looks at how we can use it wisely.

The Standards

We can't look in depth at PoE at all without understanding the standards. These are the strict guidelines of how it should be used and must be abided by.

802.3af PoE or what we now call Standard POE was published in 2003. This document set out the method of delivering power to end Powered Devices (PD) from Power Sourcing Equipment (PSE), such as a new breed of PoE enabled Ethernet Switches or in the case of legacy installations, Mid-Span Power Injectors. They were designed to provide 15.4 watts, however given the distances and potential losses over the cable and connectors, the end powered devices expected a total of 12.95 watts.

In 2009 we saw 802.3at published which answered the demands of some manufacturers of the end devices, who had been asking for more power to exploit their full features. As in the case of CCTV manufacturers with PTZ (pan, tilt and zoom) capability, it was struggling with standard POE. This new standard dramatically increased the limits, in effect doubling the power levels involved to 34.2 watts powering and 25.5 watts powered.

Doubling the Power?

Exactly what power you can get from PoE has been debated and has caused much confusion, but the answers can be found quite simply by looking at the standards.

PoE runs over two pairs, however although the load can be received over all four pairs, as in Figure 33-5 from the standard, it does not mean using all four pairs doubles the power.

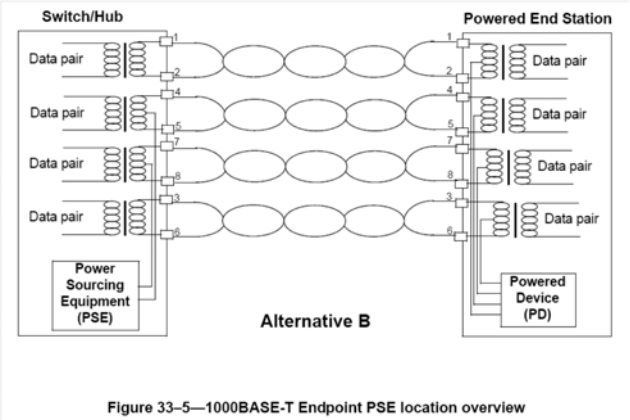

Figure 33–5—1000BASE-T Endpoint PSE location overview

At any one time only 2 of the pairs can deliver the power, even if 4 pairs are used, so the power can never be doubled in this instance.

The following statement from the 802.3at standard should clarify this point. Please remember to bear in mind that in standards parlance "Shall" is mandatory and "Should" is recommended.

"PSE shall implement Alternative A, Alternative B, or both. While a PSE may be capable of both Alternative A and Alternative B, PSEs shall not operate both Alternative A and Alternative B on the same link segment simultaneously."

Figure 33-7 gives the same Alternative model but this time using Mid-Span Power Sourcing.

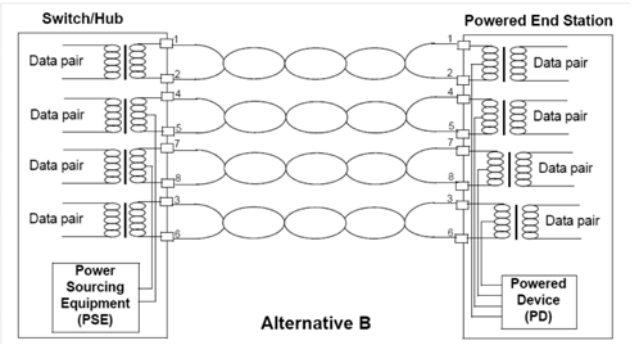

Figure 33–5—1000BASE-T Endpoint PSE location overview

With Power comes Heat

Some people still believe it's possible to increase the wattage of power used. As a standalone argument maybe it is, but it does not come without consequences.

I remember doing some experiments in school with a battery, some wire and a light bulb. The basic demonstration showed that when you connected up the circuit and the current started to flow, the light bulb sprang into life and produced light. This was caused by a fine element heating up to a point so it glowed brightly.

This shows, quite simply, that when you run a current you are going to produce heat. So put power down a copper wire and it is going to heat up.

With the increase in the level of power with POE+ we are now facing greater challenges concerning heat dissipation. This reality has lead to ISO/IEC producing a Technical Report on the heat dissipation titled 'Telecommunications cabling requirements for remote powering of terminal equipment' TR29125.

This document outlines the impact of putting power over structured cabling as well as how to mitigate the effects. Table 1 gives examples of the level of heat that can be produced in a bundle of cables.

continued overleaf

Cable bundle size (number of cables)	Temperature rise [a] °C				
	Category 5	Category 6	Category 6_A	Category 7	Category 7_A
1	0,8	0,6	0,6	0,6	0,6
7	1,4	1,1	1,0	1,0	0,9
19	2,6	2,1	1,8	1,8	1,6
37	4,7	3,7	3,2	3,2	2,9
61	6,9	5,5	4,8	4,8	4,4
91	9,7	7,7	6,7	6,7	6,2
127	13,1	10,4	9,0	9,0	8,3
169	16,9	13,5	11,7	11,7	10,8
[a] Calculated values for worst case					
NOTE 1 The temperature rise (°C) is based upon a current of 600 mA per pair, for all pairs in all cables in the bundle.					
NOTE 2 The values in this table are based on the implicit DC resistance derived from the insertion loss of the various categories of cable. Manufacturers'/suppliers' specifications should be consulted for the information relating to a specific cable					
NOTE 3 The current per pair for each category is dependent on the cable construction					

Table 1

The document goes on to outline a number of methods of mitigating this heat. These include powering all the cables in the bundle, as well as:

- Using a Higher Category Cable – (minimum 24AWG Cat5e)
- Selecting a larger conductor size decreases per unit length dc resistance
- Choose pathways and spaces with good air circulation
- Selection of applications and devices that use lower current

All the heat calculations are based on the standards, which are the only facts we have to go on.

There is one other reason why the understanding of heat is so important and that is that increased operating temperatures may reduce the length over which an application can be supported. EN 50173 series provides information with regards to reference implementations at temperatures above 20°C.

Reduced Lifespan

TR29125 highlights a further consideration, and this is the impact of the current on the connecting hardware. Each time the RJ45 plug is mated and unmated there is an arcing effect between the two contact points. As you disengage the pins, there may be a point where the load could run over just one pin. This will cause damage over time which will reduce the overall life of the product. The number of matings allowed within the component standards are being reduced from 750 to just 200 for connectors under load conditions of 600mA.

TR29125 does advise that the power should be disabled every time the connections are mated and unmated, however in the real world it's hard to believe that anyone would go to that level of effort each time they have to move and re-patch a device.

What's to Come?

As people are starting to want more power for more devices, the expectations of PoE are growing.

Any increase in power has to go somewhere. In the main it will be utilised by the end device, but we have already established that a percentage will be lost in transmission and that loss is reflected by an increase in heat within the cable.

We have illustrated what Standards compliant PoE and PoE+ equate to but there are a few vendors of PSE devices that are claiming over 100watts.

This worries me. If, as in the example shown from TR29125, a bundle of 170 Cat5e cables will increase in temperature by 16.9°C, what is the impact if the power is trebled? Could we see a doubling in temperature? If so then there will be an impact on the data carrying capabilities. The simple calculation is that for every degree above 20°C the performance has to be de-rated by 0.2%. Therefore, 20 degrees above the distance is reduced by at least 4%.

Here is the second problem: how is that heat increase going to be managed within the environment? Will it need additional cooling and ventilation within raised floor spaces?

The IEEE is already looking at the next level of PoE but it's at very early stages still. However there is a group of Manufacturers that have come forward and called themselves the HDBase-T Alliance. Their aim and ambition is to provide IP TV within the home by providing remote powering to LCD screens throughout the property up to 100mtrs. As the International Standards bodies haven't provided them with enough scope they have now released their own standard for providing 100watts up to 100mtrs over Cat5e cable.

My main concern with all of this is that the cable will be run behind walls, that contain various cavity wall insulating products meaning any heat generated will continue increasing as it has no way of dissipating.

What is possible is one thing, but the consequences must be considered. The standards are there to help us all.

Conclusion

PoE is a welcome technology and will promote the growth of Converged IP enabled systems. Designed and installed correctly it can be simple 'Plug and Play' but as power increases and the size of installations increase the problems start to appear.

My advice is use it, but make sure you understand it and don't get carried away.

This Technical Note has been produced by Paul Cave, Technical Manager, on behalf of Excel.

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