

White Paper

Is this the way forward when deploying Power over Ethernet (PoE)?

excel
without compromise.

A lot has been written about Power over Ethernet PoE, yet it is still an area of great confusion and even concern in some quarters. This paper will endeavour to discuss the reality of what is available in today's market, both Standards Compliant and Non-Standards Compliant, it will give an opinion on what the future developments might be and what is happening that could mitigate some of the concerns that have been previously highlighted and are being discussed throughout the industry.

State of Play

To start with we should first establish what the current state is with the PoE standards, as there are a large amount of false claims about levels of power that can be supported over standards compliant structured cabling.

IEEE 802.3af Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) the basics of this are outlined as 15.4Watts Powering and 12.95Watts Powered, this basically means what is sent from the Power Sourcing Equipment (PSE) such as an Ethernet Switch or a Power Injector etc and what is received by the Powered Device (PD) such as an IP Telephone, Wireless Access Point or IP CCTV Camera. The key with this configuration is the fact that the PD is the device that has the intelligence, it dictates what level and class of power it requires as well as which of the two pairs it needs to run over.

In 2009 IEEE 802.3at was published which introduced Enhanced PoE or PoE+. It increased the level of power to 34.2Watts Powering and 25.5Watts Powered, this document also redefined the term for the two levels of power to Type 1 and Type 2.

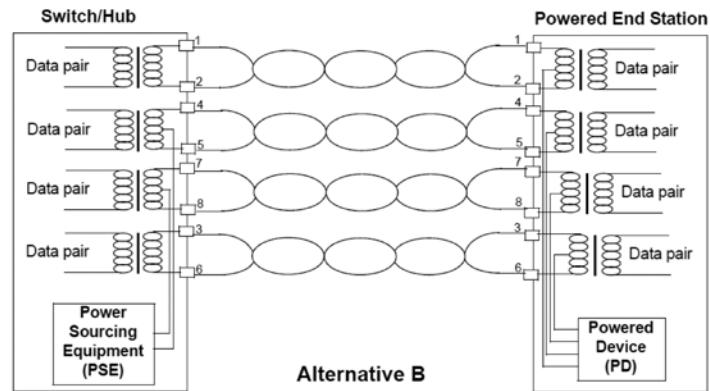
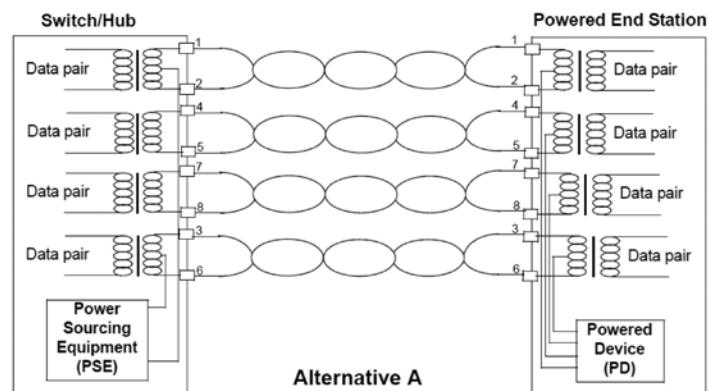
As has already been alluded to, Standards compliant PoE is based upon 2 pair powering and not all four pairs, this is highlighted within the following text from IEEE 802.3at;

"A 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"

This means a PSE should be able to deliver power on either of the two pairs however the PD will only receive on one of those pairs. The following image gives an outline of Alternative A & B. The former delivers on pairs 1,2 3,6 and the latter 4,5 7,8.

Standards Compliant Cabling

All of the developments of PoE both now and into the future are based around Standards Compliant Horizontal cabling, not thin conductor so called 'zone cable' and certainly not Copper Clad Aluminium (CCA) the latter seems to be creeping



in via distribution channels that have little or no experience of structured cabling and therefore do not fully understand the implications.

The main by-product of PoE is heat, the full extent of the impact and how it should be resolved, will be discussed later in this paper.

IEEE 802.3at is very clear about what should be used to support its operation.

"Type 2 operation requires Class D, or better, cabling as specified in ISO/IEC 11801:1995 with the additional requirement that channel DC loop resistance shall be 25 Ω or less. These requirements are also met by Category 5e or better cable"

Two parts of this statement should be clarified further with reference to the first line of the paragraph the standard also states that it should support PoE up to 100m in the channel. This can also be interpreted with the additional requirement for DC Loop resistance of $25\ \Omega$ or less, this can only be achieved by the use of solid core cable that complies with the component standard for horizontal cable, ISO/IEC 61156-1 which calls for the conductors in the cables to be a minimum of 0.51mm (24AWG approx)

The use of 26AWG cables for anything other than patch and equipment cords is not allowed due to the higher attenuation of the cables which results in shorter compliant lengths and even higher temperatures than have been tested.

What is on the Horizon?

A lot of discussion is currently going on about what the next level of power will be and when. The IEEE is under a great deal of pressure to approve an even higher level of PoE.

The current thinking is that it will approve a level of PoE called UPoE in the next 12 Months.

Cisco's Universal Power over Ethernet UPoE extends the current PoE+ by delivering 60Watts over all four pairs, whilst this is claimed in all the marketing material, they have actually adhered strictly with 802.3at, therefore the PD actually receives 51Watts at 50V. The one element that has not changed is the requirement for standards compliant cabling.

Given the involvement of Cisco Systems, there are a number of applications for this technology already being deployed such as the powering of Thin Client devices, Laptops and IP enabled Trading Turrets which further strengthens the assumption that this will be the next level we will see.

Non-Compliant Systems

Unfortunately not all systems are standards compliant despite what they may claim in their marketing materials. There have been claims of systems that can support in excess of 100Watts over Category 5e UTP.

One of the main culprits of this is HDBase-T and which is a technology that has been developed by a number of vendors and because there wasn't a standard to meet their requirements they came up with their own. It is a technology for powering remote Audio Visual (AV) devices such as display screens and monitors.

The interesting revelation from white papers produced by suppliers of HDBase-T complaint AV systems is it doesn't work in the way it is being promoted and certainly does not support the model that has been developed by 802.3at.

These white papers highlight that the distances involved are far less than 100m in fact if Ultra HD video is involved the signal can only be supported at distances of less than 35m using a Category 6 UTP cable, the channel configurations are also non compliant with the channel we have come to know in ISO 11801. The typical installation is a two connector channel, therefore a length of horizontal cable with devices connected directly at either end so it does not allow for a cross-connect patching field.

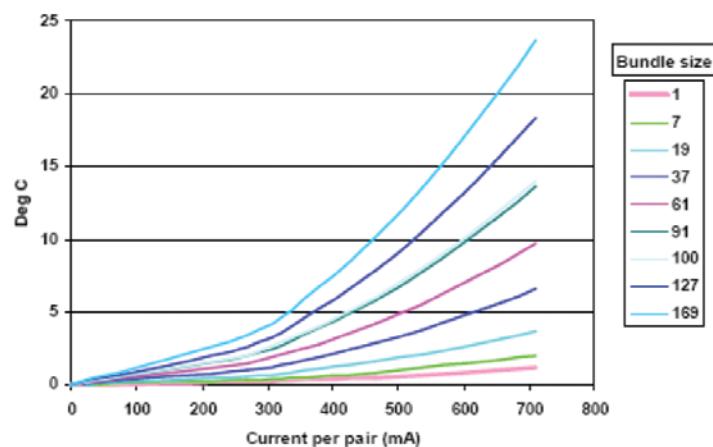
The problem is so great that one of the equipment manufacturers have developed their own high spec S/FTP cable to support the technology.

The downsides of PoE

There are two big problems that come with PoE and a lot of end-users and specifiers are either not aware of or just choosing to ignore. Unfortunately they are not going away but you can do something about them.

The first of these problems has been discussed at great length in various quarters and something is being done about the impact of heat build-up in the cables carrying PoE or 'energised' this will be discussed in far greater detail in the next section. However go back to what standards compliant PoE+ is 34.2Watts Powering and 25.5Watts Powered, the approx 9Watts difference is 'lost' in transmission, however with energy nothing is ever lost, it is just converted into another form of energy and in this case it produces HEAT and if you are discussing large bundles of energised cables it could be a substantial amount of heat.

The following chart gives an indication of the potential levels of temperature increase over the ambient.



This temperature has an impact in two areas, firstly how do you get rid of the unwanted heat the second is a factor that a lot of people ignore temperature increases above the ambient of 21°C leads to higher attenuation (Insertion Loss), higher attenuation means shorter transmission distances. Therefore in simple terms a device that is at the end of a 90m permanent link may stop working once the cables heat up.

The second major factor is the design of Secondary Equipment Rooms/Floor Distributors (SER/FD). Most Architects and Building Service Consultants are making no provision within these spaces for the higher power and heating load that PoE is generating in these spaces.

To give a simple example, this can be seen if a Cisco Catalyst is deployed, just looking at the following table and working back the numbers; if 250 devices require UPoE then there will be a power and cooling requirement of 12Kw, standard none PoE switches supporting a similar number of devices would typically have a requirement of less than 3Kw

| | Standard 802.3af Classes 0 and 3 (15.4W per Port) | Standard 802.3at Class 4 (30W per Port) | Cisco UPOE (60W per Port) |
|---------|---|---|---------------------------|
| 4200WAC | 374 | 192 | 96 |
| 6000WAC | 384 | 269 | 134 |

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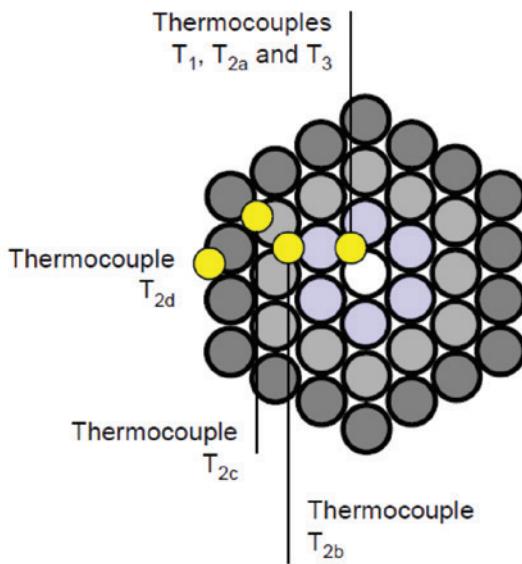
So is the power and cooling going into the SERs to support this level of load? The evidence suggests not.

Testing the Impact

There is light at the end of the tunnel in truly understanding the extent of the problems and how to mitigate the impact of PoE. In 2010 ISO/IEC published a Technical Report TR 29125 which looked at mitigating the heat created by PoE. Whilst a lot of the content was very useful and good recommendations made, unfortunately the testing methodology used was badly flawed, with too many assumptions made. The main flaw being that cables were only tested in 'Free Space' and no form of containment was ever tested.

Cenelec on the other hand have started with a very robust testing methodology of the impact and will then base its recommendations upon the findings. The testing methodology published under WD TR EN50174-99-1 has set out all the separate environments as well as methodologies. It will also cover all the separate power levels that the cable may be subject to, from PoE, PoE+ and UPoE etc. On knowing the true impact we will then be able to effectively mitigate the problem.

This Technical Report has detailed the size of the optimum bundle size for testing purposes (a bundle of 37 cables produces the best results) along with where the temperature is measured.



The results of this testing will provide far more accurate data to base mitigation strategies on.

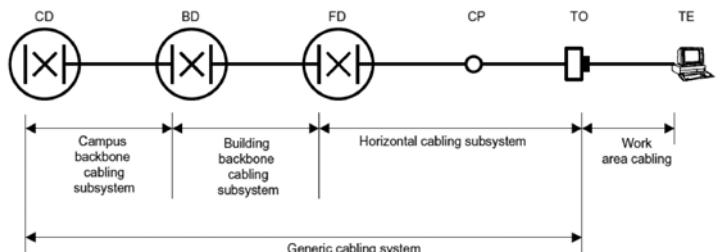
Finally there is one impact of PoE that may not be easy to overcome and that is the physical effects of constantly mating and de-mating connectors that are energised. Research has shown that unplugging an RJ45 patch cord from a socket whilst under load causes a minor electrical arc between the pins on plug and socket, whilst that arc occurs at the initial point of contact rather than the fully mated position, it does cause the gold plating of the contacts to become eroded. If this is a repeated action this erosion 'creeps' along the pins/contacts to such an extent that the overall performance is affected, therefore the standards bodies are considering reducing the minimum number of mating cycles, when energised with PoE, from 750 to 100. The TR will also look to address ways of minimising this impact.

A New Design approach to the problem

Along with the above testing method from the proposed TR producing a way of mitigating the issues of PoE, a new standard has been published that provides a design methodology of reducing the impact of PoE enabled IP devices.

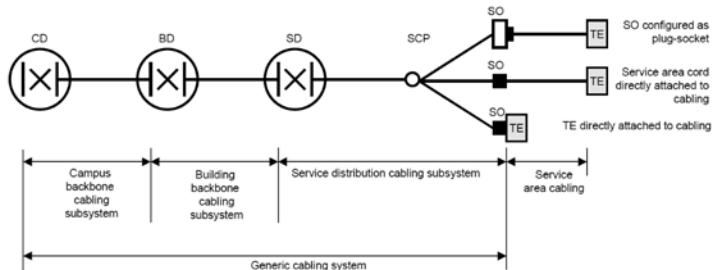
EN50173-6, Distributed Building Services, provides a set of guidelines that could further reduce the impact of PoE by moving some of the issues discussed to the edge.

It is in the same family as the rest of the series EN50173 therefore the principles remain the same the minor change being the meaning of the acronyms used, the items themselves are used in almost exactly the same way. The following images show hierarchy used in EN50173-1 and the similarities are obvious.



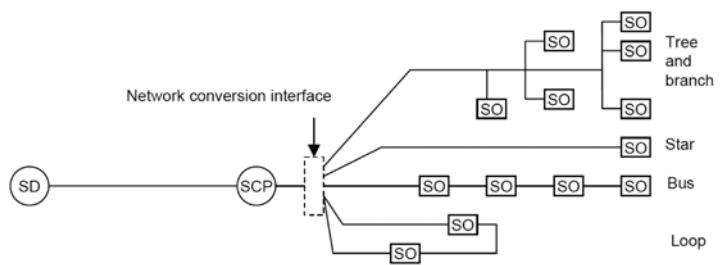
EN50173-2 – Office Premises

We have become comfortable with the above model it has been in use for many years, the following model from EN50173-6 only differs in the terms used, rather than Floor Distributor we now have a Service Distributor and rather than Consolidation Point we have a Service Concentration Point.



EN50173-6 – Distributed Building Services

The big difference happens at the SCP and beyond within the new Standard we have the ability to install an active device such as a Network Conversion Interface (NCI) to provide a point where the topology of the Infrastructure can change to adapt to the legacy systems of the Building Service Environment.



To accommodate not just the Star topology of IP Networks but also the BUS, LOOP and Tree and Branch found in BacNet, Echelon and LONworks networks that are used for Building Service applications such as access control, Building Management Systems (BMS) etc.

continued overleaf

The inclusion of the NCI at the SCP also allows us to start implementing PoE Mid-Span devices at this point. The pros and cons of this approach are quite straightforward.

Pros:

- Moving the power and cooling requirement to the edge.
 - Far less density of energised cables, leading to less heat build up on major routes
 - The cables will run smaller bundles if not single cables on diverse routes leading to less heat build up
 - The smaller requirement for power at the edge is easier to accommodate
 - Less power means less cooling, which can be typically handled by ambient cooling
 - Shorter cable runs means less power required for transmission, less heat build up
- Existing SERs can handle the power and heat requirements without major costly redesigns and dedicated cooling solutions

Cons:

- Power required at the SCP or Consolidation Point
- An extra set of connectors required in the Channel Model (however this can be covered within the 6 connector channel model)
- Requires an acceptance by the Building Services Consultants designing other elements of the infrastructure

Conclusions

PoE is a technology that is here to stay and the levels of power involved will continue to increase. With this comes the need to act responsibly when deploying it, unfortunately this is where a major problem exists. There remains a great deal of ignorance about PoE along with its benefits and pitfalls, which has only been made worse by overinflated claims made by some vendors.

The major issue is PoE is being sold as a retrofit application i.e. it is being installed onto existing structured cabling installations that may have been in use for a number of years, the design of which was carried out without a minutes thought about the use and implications of PoE. Unfortunately the effects will not be encountered on day one of use, it may even be some weeks or months before the problem comes to light when the heat builds up sufficiently to cause a problem.

This White Paper has been developed to provide an insight into the current state of play and provide some guidelines on how to come up with a Network design that can deploy PoE effectively and avoid some of the major pitfalls that have been discussed.

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