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Testing Power over Ethernet (PoE) Enabled Systems

Understanding potential impacts on the certification and testing process

Power over Ethernet (PoE) is an innovative technology that is being used increasingly to power IP telephones, wireless LAN access points, network cameras, and other network appliances. Network technicians who have implemented or are considering implementing PoE and installers offering this technology as part of their service should be aware of potential impacts on the networking testing process. Installation of some types of PoE equipment will require recertification of the existing cabling plant. Existing PoE equipment on the network may require changes in test procedures to ensure accurate testing of the data network. Additional tests on new PoE equipment will help verify and document its proper operation. This article will explain the impact of PoE on the network testing process and show how some relatively simple changes in procedures and equipment can ensure success.

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Introduction to PoE Technology

Current PoE technology has been codified by the publication of the IEEE 802.3af standard which specifies the operation of Ethernet power-sourcing equipment (PSE) and powered devices (PDs). The specification involves delivering up to 15 watts at a nominal 48 volts DC over unshielded twisted-pair wiring. It works with the existing cable plant, including Category 5, 5e or 6, horizontal and patch cables, patch-panels, outlets, and connecting hardware, without modification.

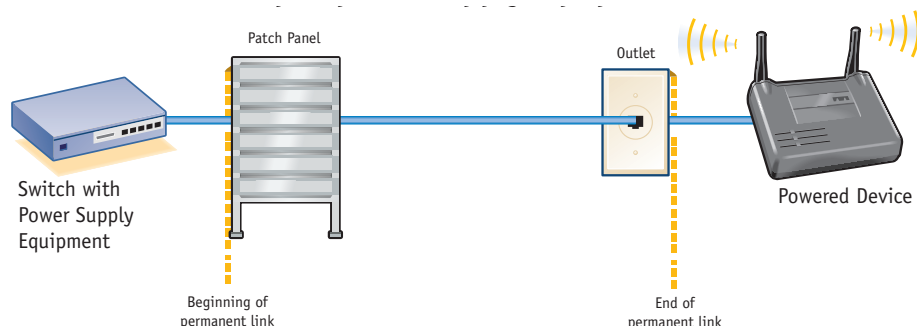
All network appliances require both data connectivity and a power supply. The advantage of PoE is it requires only one set of wires to fulfill both of these needs, reducing installation time and cost and saving space. PoE also makes it easier to move an appliance, since it can simply be plugged into a PoE enabled network jack.

Types of power-sourcing equipment

There are two basic types of PSEs: end-span and mid-span. There are significant differences between these PSEs in their effect on network testing.

End-span systems use an Ethernet switch with an embedded power supply to deliver power and data. IEEE Standard 802.3af permits end-span devices to supply power on either the 1,2 and 3,6 pairs OR on the 4,5 and 7,8 pairs of a 4-pair copper cable. End-span PSEs may be compatible with 10BASE-T, 100 BASE-TX or 1000BASE-T data transmission.

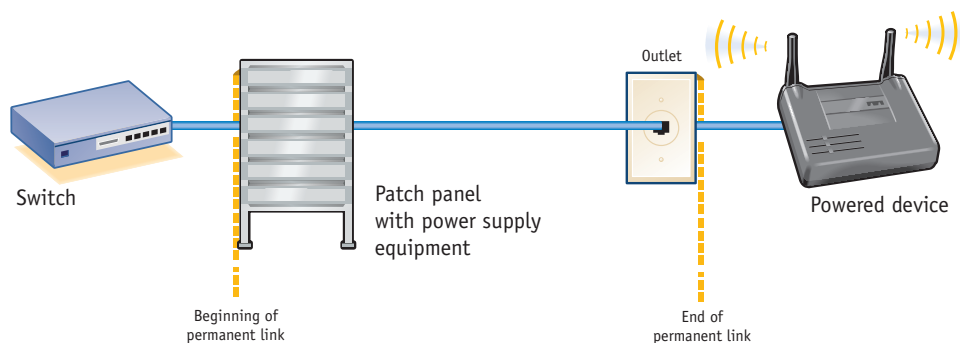
End-span power supply equipment



End-span Power over Ethernet devices are outside the permanent link. End-span devices have no effect on certification of the permanent link.

Mid-span PSEs sit between legacy switches or routers and the powered devices. Mid-span PSEs can be standalone devices or they may be integrated into a patch panel. In the latter case, each of the mid-span ports in the Power Insertion Patch Panel forms one end of a Permanent Link. 802.3af compliant mid-span devices are only permitted to use the 4,5 and 7,8 wire pairs to carry power, and the 4,5 and 7,8 pairs do not pass data traffic through the mid-span PSE. Since 1000BASE-T traffic require all four pairs to transmit data traffic, 802.3af mid-span PSEs are limited to 10/100BASE-T. Mid-span PSEs exist for support of 1000BASE-T, but these are technically non-compliant with the IEEE Std 802.3af.

Mid-span power supply equipment



With a mid-span Power over Ethernet configuration, the power supply equipment (PSE) is contained in the patch panel and is part of the permanent link. Certification should be done with the PSE turned off, and wiremap tests are made via inference of return loss, insertion loss and NEXT test results.

An important difference between power insertion patch panels and end-span PSEs is that while power insertion patch panels become part of the permanent link, end-span devices do not. The performance of the connection and quality of the termination of power insertion patch panels are major contributors to permanent link performance, so each permanent link needs to be recertified whenever a power insertion patch panel is installed. End-span devices are not in the link when it is certified and have minimal effect on network testing.

How PoE systems work

To prevent damage to existing Ethernet equipment which is not equipped to receive PoE power, PSEs run a discovery process which looks for devices that comply with the PoE specification before applying power to the lines. This discovery process works by applying a small current-limited voltage to the cable and checking for the presence of a 25 k Ω resistor in the remote device. This probing voltage is typically less than 10V and can be applied as often as every 2 milliseconds.

If it finds the resistor, the PSE then applies the full 48V specified by the PoE standard – up to a maximum of 15W. Power is provided as long as the device present draws a minimum level of current. If the device is turned off or removed, then the PSE removes the power and begins running the discovery process.

Effects on network certification testing

The DC voltage on the link is isolated from the high-frequency data signal, but it can affect test instruments. Nearly all testers use DC signals to perform basic connectivity testing such as wiremap and resistance tests. In addition, many testers contain features designed to protect sensitive measurement circuits from other active communications devices such as ISDN and POTS that might use DC voltage on differential pairs and might accidentally be connected to the tester.

When the cable is tested, there is no powered device on the line, so the PSE is in the discovery mode. The DC voltages sent as part of the discovery process will have no effect on data transmission tests such as Return Loss, Insertion Loss, and Near-End Crosstalk. But they can interfere with the DC measurements used by most network testers during the certification process to measure the resistance of the link and generate a wire map. The DC voltage generated by the PSE as part of the discovery process might accidentally trigger protective features in the network test equipment.

For that reason, DC power should be turned off for any line being tested. The simplest way to do this is to simply remove power from the PSE device. But this will have the often unwanted effect of removing power from all links, not just the one being tested.

Fortunately, most PSEs come with a software configuration utility that allows power for individual ports to be turned on and off. With power shut off to the port being tested, the data transmission properties of PoE enabled links can be tested in the same way as conventional links.

Testing the PSEs

The next question to be addressed is how to test the PSE. There are several possible approaches ranging from complex and highly accurate, to simple go/no-go, and some points in between.

PSEs can be tested with laboratory equipment designed to evaluate the performance of power supplies. These high-end devices can be configured to evaluate the performance of PSEs both in the discovery and power modes of operation. The problem is that these devices are expensive, bulky, and complicated to use. They are intended for use by equipment manufacturers – not network technicians in the field.

A much simpler and less expensive alternative is provided by simple devices that basically consist of a resistor, LED, and RJ-45 plug. These devices are plugged into the network jack and appear as a resistance to the PSE. The PSE then sends 48V power which lights up the LED. These devices provide a quick and simple way of testing PSEs, but don't provide any information about the voltage levels and power capacity of the PSE. Neither do they provide a method to document the availability of PoE power. They should be considered a quick go/no-go solution.

The most useful solution will provide more information than the simple go/no go solution and will be field-friendly. Fluke Networks recently introduced the DTX Network Service Module for the DTX CableAnalyzer. This new module (DTX-NSM) plugs into the back of the

DTX CableAnalyzer and provides more extensive PoE testing as part of the same suite of tests currently used to certify the link. This solution verifies the presence and proper voltage for PoE applications, as well as verifies the PSE is delivering power compliant with alternative A or B in the IEEE 802.3af standard. Another advantage of integrating the PoE test into the link certification is that the results of the PoE test can be documented and archived as part of the certification testing process.

A new standard and noncompliant PSEs

Up to this point, we have addressed how to test power and data on all types of PoE enabled links complying with the 802.3af standard. But this standard does not support Gigabit Ethernet, which uses all four pairs for data transmission. Consequently, a number of manufacturers have introduced Gigabit Ethernet PoE equipment which does not conform to any existing standard. Additionally, some PSEs may supply greater than 15W to support devices that require more power. This equipment has already attained a considerable market presence, and has prompted the IEEE to create a task force chartered to address these issues in an update to the standard. This 802.3at task force is charged with extending the capabilities of the 802.3af standard.

When drafted and published, the new standard is expected to provide at least 30 watts of power, which is needed particularly for high data rate access points and motor driven devices such as cameras with pan, tilt and zoom controls. In addition, the task force's objectives include researching the operation of PSEs for Gigabit and 10 Gigabit Ethernet.

Testing newer PSEs

When all four pairs are used for data transmission, the challenge is preventing DC voltage from accidentally being channeled back to the network switch or router where it could do serious damage. The manufacturers that have introduced Gigabit mid-span devices to date have overcome this problem by introducing transformers or capacitors that block DC currents from flowing back into the switch or router.

This creates an additional complication for the network testing process. The transformers or capacitors will not affect the high-frequency signals used for Insertion Loss, Near End Crosstalk, and Return Loss measurements. But, even when the power is turned off, these devices will appear as opens to a network tester using DC current to check connectivity. So the link will fail certification. To overcome this problem, configure the tester to avoid using a separate wiremap measurement. Other parameters such as Insertion Loss, Near End Crosstalk, and Return Loss will only pass if the wiremap is correct.

Conclusion

The rapidly growing popularity of PoE means network technicians need to understand its impact on the certification process. Each variety of PoE equipment has varying effects. By adjusting test procedures accordingly, network technicians can easily validate the performance of PoE systems along with the underlying Ethernet infrastructure.



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Printed in U.S.A. 12/2006 2669755 D-ENG-N Rev C