Business Case

Drivers and Applications for the Power over Ethernet Solution

Introduction

As the network has become an integral part of the enterprise and small-to-medium business, a plethora of new applications have driven new devices onto the network infrastructure. Perhaps one of the most significant of these in recent years has come through the advent of new IP telephony-based clients that were first introduced in 2000. For the first time, a user-based device that was not a desktop workstation or server was connected, with Ethernet, into the switching infrastructure. The onset of IP telephony brought a new requirement, unheard of up to this point in the LAN hub and switching technology: The requirement to provide power to that end device. Cisco Systems® was the first to innovate the capability of providing power to the end device, in this case, the Cisco® IP phone, and began work with numerous other vendors within the IEEE to create a standards-based means of providing power from an Ethernet switch port. This capability has been ratified by the IEEE 802.3af committee and is now being widely adopted.

Cisco is continuing to drive the evolution of technology innovation to standards by delivering IEEE 802.3af-compliant Power over Ethernet (PoE) solutions for the entire Cisco Catalyst® intelligent switch portfolio. By expanding its PoE support, Cisco offers greater flexibility and mobility to users by combining Cisco Catalyst Intelligent Switching capabilities with integrated power delivery to increase network flexibility and usefulness in the support of new services and applications.

PoE is typically associated with two applications: IP telephony and 802.11 wireless networking. As enterprises seek to cut costs and increase productivity, network managers today want to enable new applications to expand the "usefulness" of the network infrastructure. Although today the number of devices, except for IP phones and wireless access points, that are using PoE is limited, the completion and ratification of the IEEE 802.3af standard has accelerated both demand for the capability in the LAN infrastructure and the product plans by numerous powered-device vendors. To illustrate the diversity of industry interest, an interesting—and somewhat unexpected—application for PoE was announced by Gibson Guitar Corp, which introduced a PoE-enabled electric guitar.

Numerous more practical applications are emerging, such as video surveillance, integrated building management solutions, and remote video kiosks that will benefit from the adoption of PoE. As these—and more—applications continue to emerge, the network infrastructure will need to accommodate not only the PoE devices deployed over the last few years, but also the new PoE devices and applications they enable.

Even though these applications may not be needed today, deployment of a power-enabled infrastructure provides investment protection that can support future PoE-enabled application requirements. As the corporate buying and depreciation cycles lengthen from three to four years up to five to seven years, having the network ready means that the network manager will be able to introduce applications quickly, even if they are unforeseen today. Benefits to deploying PoE today abound, including:

- *Simplicity*—Category 5 data-grade cable is the ubiquitous data and voice cabling that is run to every cubicle and office space in a campus or branch office. PoE provides not only network connectivity, but also power to a device that needs it over the single cable. This means the facilities manager does not need to install more costly AC power at the end station to power more devices. In the case of the Cisco IP phone, the phone plugs into the data jack connecting to the switch, and the user's PC in turn connects to the IP phone. This simplifies cable management as well as the uninterruptible power supply (UPS) backup requirements and delivery for IP phones.
- *Mobility*—Low-voltage, Ethernet-powered devices can be easily moved without need for AC power wiring, reducing costs and minimizing business disruption. Wherever there is an Ethernet connection, an Ethernet-powered device can be easily deployed. In addition, PoE will accelerate the deployment of wireless access points because power, which is infrequently terminated in the plenum ceiling, can now be offered over a lower-cost Ethernet cable. This provides a better service to users, who can now reach their network resources on the wireless and wired network.
- *Operational resiliency and ease of deployment*—A centralized power delivery solution simplifies power distribution and allows for a centralized UPS deployment to minimize business interruption. This would not be possible if devices that could be powered over the Ethernet cable were connected into the building power system instead. (Imagine if a building power failure shut down the telephone network.) As stated earlier, no local AC power is required to support end devices such as IP phones, wireless access points, and video cameras, allowing for extended deployments of these devices without the incremental cost for local AC outlets and associated cabling.
- *Taking advantage of investment*—New applications such as video surveillance, remote video kiosks, and intelligent building management solutions can take advantage of an Ethernet connection for both power and connectivity.

What Is Power over Ethernet?

PoE is the ability of the LAN switching infrastructure to provide power over the Ethernet copper wire to an endpoint. This capability, often referred to as "inline power," was originally developed in 2000 by Cisco to support the emerging IP telephony solution. IP phones, like standard desktop private-branch-exchange (PBX)-supported phones, require 48 volts of power, which can be provided in one of two ways: By plugging the phone into a power outlet or by powering the phone over the network cable. The latter option was chosen because there was less chance of phone power failure. Cisco supports both its original proprietary technology for inline power and the IEEE 802.3af PoE on all the Cisco Catalyst LAN switches.

The specification for PoE calls for two devices: The power source equipment (PSE) and the powered device (PD). The Cisco Catalyst switch, when populated with PoE-capable line cards, functions as the PSE and provides power to the end device, the powered device. The powered device can be one of many different devices, including the IP phone or wireless access point. Other powered devices are introduced and covered later in this document.

The standard also supports another mode of operation. Because today many switches do not support 802.3af—or any type of inline power—the powered devices must support midspan PSE. This device sits between the LAN switch and the powered device, inserting power on the Ethernet cable to the powered device. A technical difference between the two mechanisms should be noted: If the Cisco Catalyst switch is the PSE device, the power is transmitted over the same pairs (pins 1, 2 and 3, 6) of the Ethernet cable used to transmit data (this capability is sometimes referred to as "phantom power"). If a midspan PSE, such as the Cisco Catalyst Inline Power Patch Panel, is used, then the power is delivered on the unused pairs (pins 4, 5 and 7, 8).

The 802.3af standard also provides for five power classes that a device may belong to. The PSE vendor does not have to implement all these classes and may elect to support the maximum of 15.4 watts. This may require the facilities manager to invest significantly more resources in providing PoE if a vendor elects not to use power management. It should also be remembered that even though a powered device may support IEEE 802.3af-2003 power classification, the PSE may not, and 15.4W delivery is the common denominator.

Cisco supports the capabilities spelled out in the 802.3af standards as well as its own unique Intelligent Power Management (IPM). Cisco IPM provides better efficiency in the use of power in the Cisco Catalyst switch relative to other potential PSEs. When a powered device is plugged into the PSE, the switch port must first detect whether the device connected requires power. Clearly, if the end device is, for example, a workstation, sending power down the line would be damaging to the end device. Therefore, the switch must first see if that device requires power by sending a low power DC pulse down the wire on different pairs. If a valid powered device is on the other end, the PSE will see resistance between the two pairs, thereby knowing that it can power the device.

Applications for Power over Ethernet Technology

Convergence, previously limited to the integration of voice over the data infrastructure, is really the movement of multiple parallel networks onto a common infrastructure. The IP network, once used solely for client-server environments, is seeing a dramatic increase of the reliance of the business on that infrastructure. The term "convergence," once used to denote only voice and data on the same network, now can include wireless, building security, video, and other applications now using the IP-based Ethernet network. Although the introduction of PoE is an important first step in support of convergence, providing the service to the application and communication systems must make use of the unique Cisco Intelligent Switching capabilities.

IP Telephony

Today, PoE is typically associated with two essential elements of convergence: Wireless access and IP telephony. In 2000, Cisco innovated PoE for the purposes of accelerating the convergence of IP data and voice over the common network. The ability to power the desktop IP phone using the Ethernet cable saves the network manager from having to use external power; in addition, it ensures centralized redundancy and power management to that phone. In other words, desktop users are protected from accidentally powering off their phones.

The ability to power the telephone at the end of the wire is only part of what the Cisco Catalyst switching infrastructure provides to enable the communication service. An IP telephony-based communication service has particular requirements of the network, namely that it be available and that it protect voice traffic, which has specific requirements for latency and jitter. Cisco Catalyst Intelligent Switching enables a communication service by meeting these expectations.

Availability and resiliency are critical requirements that the Cisco Catalyst switches solve by providing capabilities at the product and protocol level. Each of the Cisco Catalyst chassis-based switches provides route processor redundancy (RPR), ensuring that supervisor engine failover can occur rapidly. Cisco offers a rich protocol suite dedicated to availability considerations, including rapid spanning tree, default gateway redundancy, and industry-leading Cisco IOS® routing protocols. Combining these features allows the network to converge from the millisecond to the sub-five-second range.

To protect latency and jitter, the Cisco Catalyst switches provide numerous quality-of-service (QoS) mechanisms. QoS is not merely about the number of queues available per port—it also is about intelligent mechanisms to classify traffic, using the architecture and policy created by the network manager. This ensures that all traffic can be categorized and given various levels of service dependant on that policy. Voice traffic, therefore, can be given the strict priority required in the network.

Wireless LAN

A new use for PoE that emerged throughout 2002 and 2003 has been to power wireless access points. Wireless connectivity has been key to the delivery of network service to users, ensuring that they have continuous access to the network and resources regardless of their location within the campus network. However, the network manager has been faced with the practical facilities problem of how to power a device located in the plenum ceiling. PoE effectively solves that problem by powering the device over a standard Ethernet cable, a cable that is already in the ceiling in order to reach user desktops. This saves the network and facilities managers the cost of installing power where it would not typically be found.

Powering of the access point allows for basic connectivity of the user onto the network so that the user can access network resources and applications. However, the service to that user must ensure numerous key items to meet both the user's expectation for service and the network manager's expectation for how to "safely" deliver that service.

Wireless networks are inherently insecure, and basic mechanisms to secure these devices are often not implemented, allowing a "hole" in network security that can be exploited. Cisco Intelligent Switching offers numerous capabilities to meet this user service. Cisco IPM detects and enables power to the port. As the device connected to that port comes online, or as wireless users associate to the device and thereby the network, Cisco identity management capabilities validate that user's access to the network by comparing the user's login using IEEE 802.1x with a RADIUS server. If the user is allowed, the user is placed in the correct VLAN; if not, the user can be denied access or quarantined into the "guest VLAN."

IP Video Surveillance

PoE is breaking out of the "traditional" applications of wireless and telephony and beginning to see rapid deployment in video surveillance over the IP network, another relatively new technology. Traditional video security systems, typically closed circuit television (CCTV) systems, use separate cabling infrastructures from the data network, require racks of video tape recorders, and typically have no system redundancy. The introduction of digital video recorders (DVRs) was the next step in the evolution of hybrid CCTV/IP networks, where the analog cameras connect into the DVR, which in turn digitizes the image to allow for transit over the IP network. The final stage of this evolution is the deployment of IP video cameras themselves. It is here that PoE has a role.

IP video cameras that are already on the market use 802.3af for power. Because there is now no requirement to run AC power out to the camera or to install a separate cable infrastructure, more cameras can be deployed in the campus, branch office, or retail store. This allows a security department to better track employees and customers for loss prevention and productivity analysis.

Because video surveillance—or any building security mechanism—is critical to business operation, Cisco Intelligent Switching becomes crucially important. One of the first components is the availability of the switch itself, such that a power failure does not affect business security. Dual power supplies or redundant power systems and redundant supervisor engines ensure that the switch remains active during a failure event. Availability protocols discussed earlier ensure fast convergence if a link or device fails, providing nonstop video surveillance. QoS can be enabled to protect the quality and integrity of video streams that are typically stored for later analysis. Finally, security capabilities inherent in the network ensure that unauthorized access, denial-of-service attacks, or man-in-the-middle attacks can be prevented.

Building Management

One of the new emerging applications for PoE is in the area of building management. This is a new area for the IP LAN infrastructure to address because the interests of the network manager and facilities manager differ significantly. However, as the network increases in usefulness to the business, convergence of some building management functions becomes advantageous. IP-based video surveillance is the first application in building management to make its way onto the Ethernet network. One example is magnetic card readers, which may be powered using power over an Ethernet cable that would allow tracking of personnel for safety or security purposes. This can, in turn, be linked with the IP video surveillance system to verify whether or not the person using the badge ID is the correct person. These systems could then be linked with the RADIUS server used by the network to verify the identity of users accessing the network and ensure that they are authorized. Linkages between online systems and databases and building security systems are possible with the convergence of multiple parallel networks.

Retail Video Kiosks

Many retail companies are finding new ways to advertise to their customers, both in the store and outside of it. The delivery of video to monitors placed around a store is one clear way to send messages directly to customers. The major challenge to this type of deployment, from an infrastructure standpoint, has been the need to provide power to more locations—an expensive requirement. Some vendors are now looking at monitors that support PoE. These monitors receive both their power and video stream from the LAN switch and video distribution network that allow these systems to be deployed quickly and cost-effectively.

Cisco Leads the Industry in Power over Ethernet

Cisco was the first to innovate PoE, and the company has been driving the evolution of technology to standardization by delivering IEEE 802.3af-compliant PoE solutions to the entire Cisco Catalyst intelligent switch portfolio. Cisco delivers 802.3af-compliant PoE for the Cisco Catalyst 6500 Series, Catalyst 4500 Series, and Catalyst 3750 Series switches, and introduces the Cisco Catalyst 3560 Fixed-Configuration PoE Switch. Building from an installed base of more than 16 million powered Ethernet ports, Cisco delivery of standards-based PoE switches allows customers to expand their networks to support new Ethernet-powered devices. Cisco Catalyst 10/100/1000 and 10/100 PoE solutions further enhance the value of the Cisco Catalyst portfolio by enabling connection of new devices to the network, and these solutions receive both network connectivity and power from a single wired connection.

PoE and Gigabit Ethernet

Cisco delivers both 10/100 and 10/100/1000 PoE ports, enabling the network administrator to take advantage of higher-bandwidth connections, thereby resulting in greater network optimization and user productivity. Deploying Gigabit Ethernet ports with PoE capabilities allows for maximum investment protection, enabling an upgrade-free migration capability and affording organizations the ability to lower overall cost of network ownership and use the LAN infrastructure to greater advantage by reducing capital expenditures, simplifying manageability, and lowering operating costs.

Cisco is the first vendor to deliver high-density 10/100/1000 ports that deliver 802.3af PoE. The Cisco Catalyst 6500 and Catalyst 4500 series offer 48-port 10/100/1000 modules that support full module density of standards-based PoE delivery. By integrating PoE capabilities into 10/100/1000 ports, customers can take advantage of the benefits of higher bandwidth with power support for new network-connected devices. Although many of today's powered devices may not take advantage of Gigabit Ethernet connections, deploying 10/100/1000 with PoE provides the greatest degree of investment protection, allowing for transparent support for future 10/100/1000 devices without the need to replace LAN switching hardware.

Intelligent Power Management

Cisco Catalyst intelligent switches not only support a complete implementation of the IEEE optional power classification features, they also further extend these capabilities with Cisco IPM. Cisco IPM enables scalable, intelligent management of power delivery for all PoE ports in the switch. It enables the granular control of power delivery to each PoE port, allowing for power reservation, more granular power allocation, power oversubscription management, and power prioritization, thereby extending the manageability of PoE deployments by minimizing wall-power requirements and maximizing power utilization on a per-port basis.

To address the requirement to provide PoE cost-effectively and efficiently, Cisco Catalyst switches support IPM whereby the powered device and PSE negotiate their respective capabilities to explicitly manage how much power is required to power the device and also how the PSE-capable switch manages the allocation of power to individual powered devices. Many—if not most—powered devices do not require the full 15.4 watts that the 802.3af standard requires. Cisco uses the Cisco Discovery Protocol [on the Cisco Catalyst switch, Cisco IP phone, and Cisco wireless access point to communicate the amount of power needed by the device. By default, Cisco provides 7 watts of power to the powered device, unless the powered device "asks" the PSE for more power by using the Cisco Discovery Protocol. This enables the facilities manager to be more conservative in power planning for the wiring closet, where the PSE is installed.

Cisco IPM uses the Cisco Discovery Protocol for extended device manageability and more granular per-port power management. Additional support for Cisco Discovery Protocol maintains backward compatibility with installed Cisco devices and provides deeper granular control for PoE delivery. This enables network and facility managers to preallocate power and provide managed power oversubscription to allow for deployment of a higher number of devices that require lower power in a standby state. Additionally, specific ports that need to maintain power can be reserved if the switch power system becomes oversubscribed, ensuring that a critical end device (a badge reader, for example) receives consistent power.

Investment Protection

Many customers planning to implement a new network want to know that their infrastructure will support convergence of data, voice, and video, even if they are not considering convergence today. Investment protection is a major consideration, not only for networking equipment that has already been purchased, but also for new deployments.

Cisco continues to deliver on its promise of evolutionary design, delivering superior investment protection and enabling customers to gain the highest possible advantage from their infrastructure investments by "building in" backward and forward compatibility whenever possible. The Cisco Catalyst 6500, Catalyst 4500, and Catalyst 3560 series switches were designed with support for PoE. Each of the modular platforms supports the new standards-based PoE line cards, allowing customers to gain a longer deployment life from their infrastructure investment. The Cisco Catalyst 6500 Series provides an incremental benefit by offering field-upgradable 10/100 and 10/100/1000 line cards that allow users to add PoE capabilities when needed, reducing initial capital expenditures and allowing for a pay-as-you-grow approach.

The new 802.3af PoE line cards in the Cisco Catalyst 6500 and Catalyst 4500 series chassis-based switches, along with the Cisco Catalyst 3750 and Catalyst 5360 PoE fixed-configuration switches, support both Cisco prestandard PoE and 802.3af PoE delivery. In addition, future powered Cisco end devices, such as IP phones and wireless access points, will support both the original Cisco implementation and the 802.3af standard, allowing customers to take advantage of their installed prestandard PoE (inline power) line cards whenever and wherever possible. This ensures continuing compatibility with customers' current installed products, as well as with future devices. It must be noted that some future powered devices, from Cisco or other vendors, may require higher power than can be supported by Cisco pre-standards-based PoE products, and therefore, would require the higher power output provided by the 802.3af PoE interfaces.

Customers who have deployed Cisco powered end devices such as IP phones may not need to upgrade to the new 802.3af PoE ports. Cisco chassis products support both the Cisco inline power implementation and the 802.3af PoE modules in the same chassis simultaneously.

Cisco has shipped more than 16 million inline PoE-capable ports on the Cisco Catalyst 3500XL, Catalyst 4000, Catalyst 4500, and Catalyst 6500 series of Ethernet switches. This innovation was quickly recognized within the industry, and the IEEE started work to standardize PoE implementations to enable multivendor interoperability. As with other Cisco innovations, Cisco supports both the standard IEEE 802.3af as well as Cisco inline power, delivering intelligent power management extensions and investment protection.

Scalability and Expandability

Cisco delivers a highly scalable solution by enabling simultaneous deployment and support of a high density of PoE ports. The Cisco Catalyst intelligent switches were built with PoE in mind and, therefore, have the inherent power system and capacity in place to enable simultaneous operation of several 802.3af PoE ports—in many cases up to the density capacity of the chassis. Cisco Catalyst IPM capabilities provide further benefits by enabling facilities and network managers to have more granular control in managing per-port power, allowing for higher levels of oversubscription and minimizing wiring closet power requirements.

In addition, PoE combined with Cisco Catalyst Intelligent Switching capabilities broadens the deployment options and usefulness of the switching infrastructure, enabling the support of advanced application deployments and new network devices. The inherent intelligence in the Cisco Catalyst switches further benefits the new, power-enabled applications by ensuring availability, granular traffic control, and integrated security.

Conclusion

Cisco expands its PoE (inline power) support, offering greater flexibility and mobility to users by combining Cisco Catalyst Intelligent Switching capabilities with integrated power delivery. This increases network flexibility and usefulness in the support of new services and applications. Cisco delivers both 10/100 and 10/100/1000 PoE ports, enabling use of higher-bandwidth connections, and resulting in greater network optimization and user productivity. Deployment of 10/100/1000 Gigabit Ethernet ports with PoE capabilities allows for maximum investment protection, enabling upgrade-free migration ability and enabling organizations to lower overall cost of network ownership and thereby use the LAN infrastructure to better advantage by reducing capital expenditures, simplifying manageability, and lowering operating costs.

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