



Powering the Converged Network: An Analysis of the Power over LAN™ Standard And Implications

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ABSTRACT

Power over LAN™ is a revolutionary technology that integrates data, voice and power on standard LAN infrastructure. It is the first system on the market to supply reliable, uninterrupted power to Internet Protocol (IP) telephones, wireless LAN access points, and other Ethernet devices using existing commonly used Category 5 cable infrastructure.

This technology, when used in conjunction with a centralized uninterrupted power supply (UPS) ensures continuous operation during power failures. Power over LAN technology saves time and cost of installing separate power cabling, AC outlets and wall warts, as well as eliminates the need for a dedicated UPS for individual devices.

The implications of Power over LAN are enormous for network infrastructure and end users. Consolidation of power and data, in order to simplify installation and deployment, creates outstanding opportunities for Power over LAN technology. A large number of applications will reap the benefits from the technology, such as IP telephony, Wireless LAN, Web cams, Laptop computers, Palm computers and PDAs, Fire alarms, Audio and Video remote monitoring, Bluetooth Access Points, Residential Gateways, Access Control and Security devices.

The power delivered over the LAN infrastructure is automatically activated when a compatible terminal is identified, and blocked to legacy devices that are not yet compatible. This feature allows users to freely and safely mix legacy and Power over LAN compatible devices on their network. The power is injected by either new generation Ethernet switches (end-Span) or by a dedicated patch-panel like device, residing between an ordinary Ethernet switch or hub and the terminals (mid-span). Mid-span devices are available with 1,6,12 or 24 ports. The Power over LAN technology is designed in a way that does not degrade the network data communication performance or decreases the network reach.

*The Ethernet standard body, the IEEE 802.3 has initiated a task force, called the **802.3af**, which specifies the method to deliver power over the LAN. Draft 3 of this new standard is currently available, and the official standard release is expected by July 2002.*

Power over LAN 802.3af compatible Ethernet switches, mid-span and terminals are currently available by most leading network equipment vendors including 3Com, Avaya, Nortel, Cisco, Siemens, NEC, Agere, Proxim and many others. The majority of IP Telephone sets and Wireless LAN access points are already equipped to receive their operating power via the LAN.

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INTRODUCTION

Despite improvements in distributed computing, data networks remain as vulnerable to power failures as they did 20 years ago. There have been improvements in battery and alternative power technologies no doubt, but deploying this technology to every juncture in the network is prohibitively expensive and a management nightmare. The net result is that while data networks are capable of meeting all of a corporation's requirements, companies must still spend millions of dollars on alternative infrastructure to support critical voice, security and alarming services.

Now a revolution in power distribution addresses these and other opportunities. An emerging industry standard will soon enable companies to distribute power over their Ethernet cables. A simple idea, but providing power on the data network is the catalyst to an enormous array of corporate and consumer opportunities.

Consider the promise of running telephony over the data networks. New applications are enabled, many that are just now being developed. Unified messaging is but one example where voice mail, email and fax are integrated into a common mailbox. At the same time, companies can realize huge cost-savings. A single voice-data network reduced, personnel and equipment costs. Integrate IP telephony with network directories and administration costs are dramatically lowered. Even the sheer cost of the phone system is significantly lower where on the backed IP telephony switches may run just \$20,000 instead of the \$150,000 needed for a proprietary PBX.

However, before Power over LAN, corporations could not commit their mission critical voice systems to run on the data networks. Losing data during a power outage is one thing, but losing data and voice during an outage is something else entirely. By supplying power over the same cable as the data network, these systems can now deliver the kind of reliability expected from a business class phone system.

Power over LAN will improve the resilience of other aspects of the network. Manufacturers of printer sharing devices, for example, will be able to insure printers are available even when power fails. Storage device manufacturers can insure that their network-attached units will continue to backup even when power outages hit. PCs may not receive enough power to be driven fully off of Power over LAN networks, but they will receive sufficient power to maintain memory information is not lost. And webcam and surveillance cameras can now be connected on the data network saving companies on building out alternative networking infrastructure. The same goes for fire and burglar alarm systems.

Integrated networks enable mobility as well. Corporations can benefit tremendously from mobile technologies, like 802.11, the standard for high-speed wireless networks. These technologies enable unobtrusive networking – where users can connect to the network without any modifications to the hardware or software. Imagine the convenience of tapping into the corporate network while meeting, say in the conference room, instantaneously. No network wires to connect. No software to reconfigure.

However, mobile technologies require their own infrastructure. Access points relaying the wireless signal to the physical network must be strategically positioned around the company. Often these access points need to be located in places, like the ceiling, where the necessary power lines and data access are not readily available. An integrated power-data network solves that problem, enabling ubiquitous wireless communications, and a whole lot more.

Outside of the company, consumers stand to win with Power over LAN as well. For years, visionaries have dreamed of smart-homes filled with network-aware appliances. Air conditioners, ovens and refrigerators, wired with the smarts will be remotely activated. Imagine, on hot summer day, being able to come home to a cool house or for that matter a cool car, at the touch of a button on your handheld device.

The vision of networked appliances, however, has been hampered by the pragmatic realities of design and implementation. How can an appliance that's been turned off be activated? How should the signal reach that appliance? Knowing that networking is at best an added feature for these appliances, how can the necessary capabilities be cost-effectively added to the appliance? The list goes on.

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The combination of Power over LAN and the Internet address these problems. Now manufacturers can add a remote control subsystem within the unit. These subsystems can be manufactured for only a few dollars yet provide the necessary smarts for turning on and controlling the appliance. And where would the power and data connectivity come from? Power over LAN of course. A Power over LAN-compliant plug would connect the appliance to a network, drawing sufficient power to run the subsystem at the same time providing a connection to the Internet. Once connected to the Net a user anywhere whether at the office on the corporate Intranet or on the train using a wireless Internet service, could log-in and control the appliance

Or consider the plight of traveling executives. Increasingly workers are on the move. Coast to coast travel today is commonplace. Trans-oceanic travel is becoming the norm. The long times spent on these flights increasingly represent a huge source of downtime for today's companies. Today's battery technology simply cannot provide sufficient power for a trip cross-country let alone over the Atlantic. Even then users remain disconnected from the increasingly important corporate Intranet.

Airplane manufacturers recognize the problem and are starting to address these issues. Newer planes provide power outlets in the armrests for driving a small appliance, like a laptop. Boeing has announced an onboard communications service, dubbed Connexion, for browsing the Net. Aviation electronics manufacturer, Rockwell Collins, has teamed with media supplier News Corp to provide comparable functionality.

Power over LAN provides manufacturers like Boeing and Aviation-Rockwell Collins an easy and inexpensive solution for implementing both services. The laptops may not draw all their power from the Power over LAN-compliant network, but they can draw enough to quadruple or quintuple the length of a battery charge. By offering a single connection for power and data, users only have to bother with one cord. Using a single network and connector further reduces the costs of implementing the service.

And should any of those executives find themselves in Paris, for example, they'll be able to use the same RJ-45 plug for power that they do in US. No more hunting for country-specific adapters to plug a laptop into a foreign outlet. With hotels increasingly supplying Ethernet access to the Net, they can forget about having to fish out phone adapters as well.

But the requirements for those services are not only limited to airplanes or users traveling to foreign countries. There is no reason why trains and cars should not come with comparable functionality. Commuters may not spend 10 hours reaching their destination, but providing the same kind of ubiquitous access that's available from a mobile phone would still be in high demand. Again, Power over LAN networking addresses this challenge.

THE POWER OVER LAN STANDARD

Pushed by PowerDsine, the Institute of Electrical and Electronics Engineers (IEEE)¹ formed a taskforce to standardize an approach for passing power over Ethernet, the most widely implemented data networking specification. The taskforce, called 802.3af, is being run under the auspices of the 802.3 workgroup, the same group that developed the original Ethernet specification.

With a standard closing within the year, Power over LAN will take the first step towards enjoying the same benefits of any open system. There will be a wide range of vendors providing Power over LAN solutions ultimately providing customers with multiple supply sources. Vigorous competition will ensue reducing prices and differentiating products. Consumers will be able to purchase powered-enabled gear the way they purchase any other piece of networking equipment.

PowerDsine has played a fundamental role in the formation of this market. The original concept for the specification stems from PowerDsine as does much of the substance behind the standard. PowerDsine's implementations of the technology have been adopted by networking leaders, like 3Com, Siemens, Avaya, Nortel, Ericsson, NEC and many more. The pioneering work done by the PowerDsine team has earned the admiration and respect of the peers within the standard group as well.

¹ For more information on the IEEE see <http://www.ieee.org>. Information about the 802.3 working group can be found at grouper.ieee.org/groups/802/3/af/

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BACK TO BASICS

To plug into Power over LAN, a keen understanding of the specification is needed. Much of this hinges on being familiar with Ethernet fundamentals. While reviewing the original Ethernet standard is beyond the scope of this document, there are several points that are important to know.

The 802.3 committee has defined four main Ethernet specifications each operating at different speeds. Those speeds are 10 and 100 Mbits/s and 1 and 10 Gbits/s. Each of those four standards use a range of cabling types and configurations producing a myriad of specifications.

The 802.3af group is focusing on the 10 and 100 Mbits/s Ethernet operating over category five unshielded twisted pair (UTP/FTP) cabling the kinds of Ethernet commonly used in corporate networks.

These two Ethernet specifications, 10 and 100 Mbits/s Ethernet over cabling, are implemented in a star-wired configuration as described in the 10baseT and 100baseT standards defined by the 802.3². Simplistically, at the heart of these network is a wiring hub, or more recently today an Ethernet switch. Cabling runs radiates out from ports on the hub or switch to the networked device forming a kind of star (hence the term star-wired). Devices must be situated within 100 meters of the switch or hub (see figure #1).

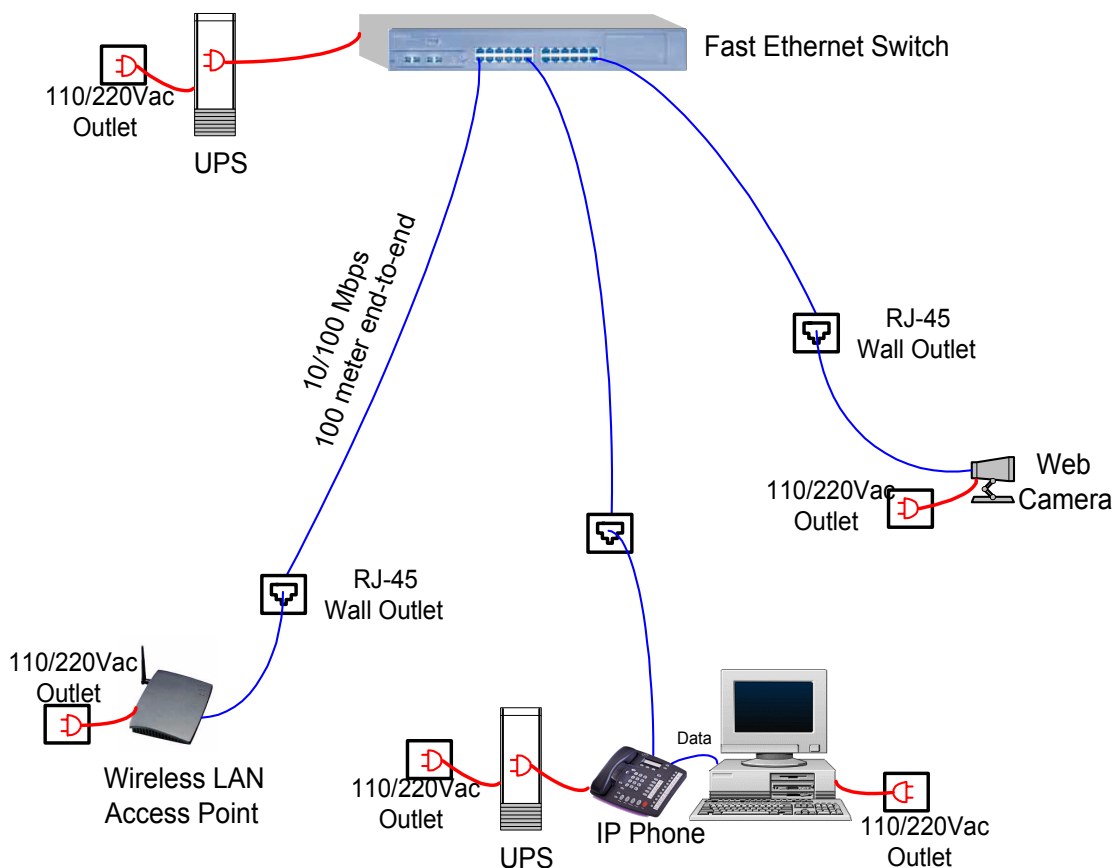


Figure 1: Today's Ethernet networks are typically wired in star configuration. Ethernet phones are connected to a port on the Ethernet switch and pull their power from the wall.

² For more information about 10baseT and for 100baseT see: <http://standards.ieee.org/catalog/IEEE802.3.html>



THE CHANGE

The basic network architecture and the underlying cabling of the 802.3af compliant network remains the same as a standard 802.3 network, yet there are four significant differences.

Let us start at the core of the network. In order for the network to carry power, one needs to add a power sourcing equipment (PSE). This is basically the source of power and the means to integrate that power onto the network.

Not only does the PSE inject power into the Ethernet network, it also provides a detection method for determining whether the Ethernet device on the other end of the cable, the Powered Device (PD), is 802.3af compliant or not. Most vendors today implement the PSE technology outside of the existing switch, a technique called a midspan solution. AVAYA and Cisco also implement this technology inside the switch, called an end-span solution. PowerDsine offers both solutions.

Attached to the PSE is the UPS. Today's networks rely on discrete power-backup solutions. A UPS is connected to each device that requires alternative power. With the Power over LAN solution, this function is centralized in a UPS connected to the PSE, which in turn may require further changes in the environmental conditions of the room needing to support this UPS with all of its electrical and cooling requirements.

Management may also be added to monitor and control the PSE. This management function may be integrated into a standard network management platform using the simple network management protocol (SNMP) or through a custom platform. Beyond the basic control of the PSE, the management stations provides additional power management functions, like power quality of service (QoS) where key users are given higher priority to power in the event of a outage.

At the periphery, if required, the device, like an Ethernet phone, can use a splitter to separate power from the Ethernet signal. This splitter can be integrated into the device or for new devices be situated in the wall or the desktop. No other changes are required to the network. The cabling and all existing Ethernet devices remain unaffected.

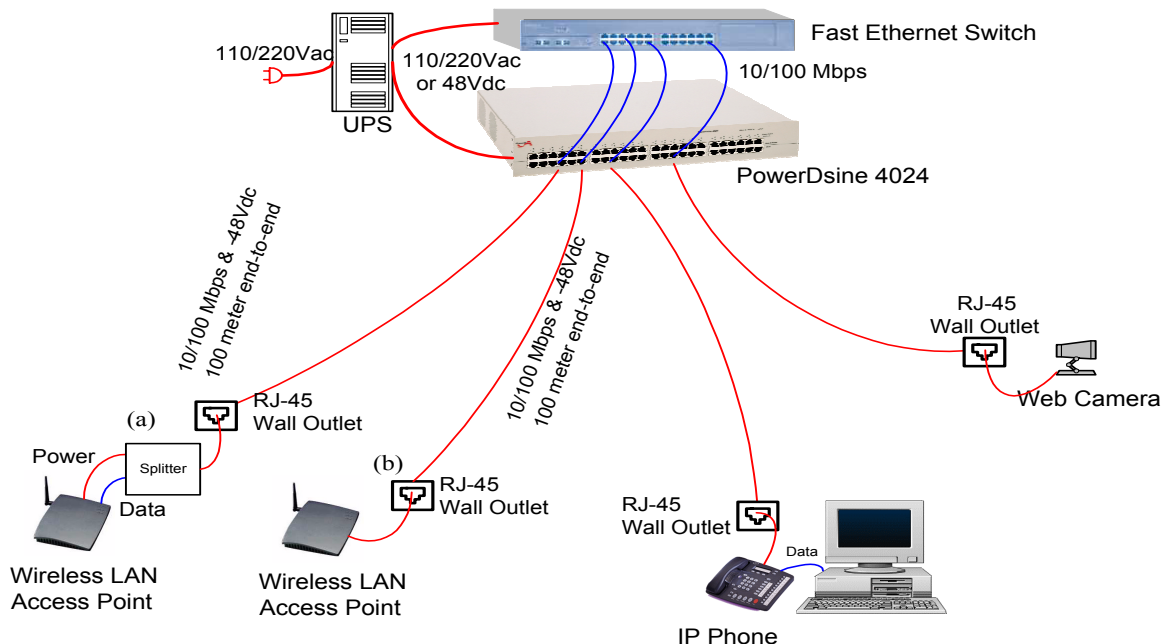


Figure 2: With a mid-span solution, a powered hub connects to the existing switch and the end devices, inserting power into the line. A splitter outside the device (a) or inside the device (b) removes the power and sends it to the terminal device.

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THE WIRING

Wiring presents the biggest challenge to the 802.3af networks. It's the wiring (and patch panel connectors) that impacts the amount of current that can be carried and how the power can be inserted into the line. Although Ethernet cabling can handle 1 to 2 Amps of power, about enough power to drive an inkjet printer, the actual implementation of 802.3af looked at the weakest link, the patch panels and various connectors and limited the power to 15.4W (44V to 57V) from the PSE. Reducing the power loss on the cables at the 802.3 limit of 100m, one arrives at a maximum of 12.95W available for the PD. It is amazing to discover how many applications are satisfied with this power level. It is also sufficient to charge a laptop battery, while on standby!

THE DISCOVERY PROCESS

The last thing a network manager wants is to start changing the configuration of existing Ethernet devices. Insuring that devices can remain attached to an 802.3af network without being damaged requires a robust detection mechanism for identifying whether or not the installed device is 802.3af compatible. What's more, the mechanism must identify the devices as 802.3af compatible without modifying the end-node.

The 802.3af calls for resistor detection. The PD incorporates a circuit, which presents a 25K Ohm resistor to the line. When the power source injects current into the line, the device measures the voltage on the input line. If the resistor is identified, the PSE turns on the 48V power, and the PD automatically connects the DC/DC stage and powers on.

PowerDsine's large capacitor approach is the pre-standard approach commonplace today. It allows a safe detection scheme without altering existing products. This is particularly critical given the competitive pricing environment of markets like IP telephones. Furthermore, PowerDsine's solution is the only one that can detect existing IP phones so leading equipment manufacturers like 3Com, Avaya, Ericsson, Nortel, and Siemens, will not have to upgrade their equipment. At the same time, the large capacitor method can accurately detect Power over LAN equipment without damaging or degrading the performance of non-compatible devices.

PowerDsine's technology, which allows either 802.3af or the pre-standard capacitor detection inside a single midspan unit, provides an easy migration path for companies who want to integrate here and now this technology with their network units, and later on migrate to the 802.3af standard. This approach has been widely accepted by many of our partners.

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POWERDSINE POWER OVER LAN PRODUCTS

Power over LAN compatible Ethernet switches, mid-span and terminals are currently available by most leading network equipment vendors, including: 3Com, Avaya, Nortel, Cisco, Siemens, NEC, Agere, Proxim and many others. The majority of IP Telephone sets and Wireless LAN access points are already equipped to receive their operating power via the LAN. PowerDsine is the driving force behind and the source of technology for most of these applications and vendors.

PowerDsine offers two types of solutions. Midspan Power over LAN Hubs, with 1, 6, 12 or 24 output ports, are connected in cascade to the Ethernet Switch/Hub. The PowerDsine 6000 product series are compliant with the forming IEEE 802.3af standard and are backward compatible to existing devices in production and design, including all major IP telephones and Wireless LAN access point terminals. This allows customers to seamlessly migrate from their current installation base to future IEEE standard compliant products.

The midspan devices sit in tandem with existing Ethernet or Fast Ethernet switches and enable a unified supply of data, voice, video and power through a single access point by sending power over standard Category 5 twisted pair cable. As a result, enterprises can deploy IP telephony and other devices without the time and cost required to install separate power cabling to existing infrastructure. In addition, Power over LAN provides continuous service during power outages by utilizing the same centralized, uninterrupted power supply that backs up the network. This architecture enhances a customer's investment in both Category 5 infrastructure and in Ethernet switch equipment.

The PowerDsine 6000 family of products includes the PowerView SNMP Management System, which offers complete remote management capabilities enabling easy online supervision, configuration, monitoring and control of PowerDsine's Power over LAN devices. Power Management also monitors the unit's input voltage and current per port to help network managers optimize uninterruptible power source (UPS) battery resources. The new Power over LAN Hubs are compactly designed with a1U height allowing easy rack mounting and consuming minimal space in the wiring closet.

PowerDsine also offers to Ethernet Switch vendors a new embedded IEEE 802.3af compliant, Power over LAN™ Single Inline Package (SIP) solution, which is easily integrated into Ethernet switches. The two sets – the PD-IM-7124 (supporting 24 ports) and the PD-IM-7148 (supporting 48 ports) - are easily integrated and require minimal footprint in both existing and future Ethernet switch designs.

ABOUT POWERDSINE

Established in 1994, PowerDsine Ltd.'s headquarters and R&D facilities are in Hod Hasharon, Israel. Its US subsidiary, PowerDsine, Inc. is located in Farmingdale, New York, USA. In Europe, PowerDsine Germany and Sweden handle European sales and technical support, with PowerDsine Japan and Korea focusing on sales efforts in Asia. The company uses outside contractors in Israel and the Far East to cost-effectively manufacture its products.

GET POWER OVER LAN

The networking infrastructure is poised for tremendous growth. The transition from a data only utility to that which delivers data, voice, and video is not an evolutionary change, it is revolutionary. Fulfilling on that vision though means delivering the reliability of existing phone and facility networks. PowerDsine's in Power over LAN product holds that key. With high-quality engineering and innovative software, backed by proven field trials, Power over LAN is the right solution for any OEM interested in being a catalyst to that change. *Interested in partnering with the leading force in Power over LAN-compliant networking? Check out <http://www.powerdsine.com> for more information about PowerDsine and application notes on how to build in Power over LAN-compatible devices.*

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