Better Power Management with Powered Data Ports

White Paper

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Abstract

This paper describes the challenges associated with supplying power via external power supplies to serial-, USB- and Ethernet-connected peripheral devices in enterprise applications such as retail/Point-of-Sale (POS) and mobile computing. It also provides information about the benefits of supplying power over the same interface used for data transfer, via powered data port technologies (powered serial, powered Ethernet and powered USB).

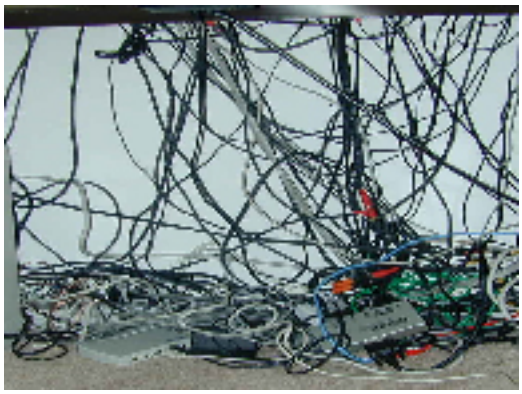
The Problem

Today's work environments are becoming more space efficient every day, as industry does its best to get the most value out of each square foot of rented or purchased space. This is especially the case in such industries as retail/Point-of-Sale (POS), mobile computing and aeronautics.

Today's workplace is also becoming more and more automated, with desktop PCs, notebook PCs, PDAs, network hubs, cell phones and numerous other electronic devices. In an industry like retail, each POS station may contain a PC or thin client, cash drawer, receipt printer, keyboard, mouse, bar-code scanner, signature capture device, credit card magnetic stripe reader, pole display and possibly even other devices.

Since each electronic device requires power to operate, the proliferation of device power supplies, cables and power strips is epidemic. The space occupied by these items is directly contrary to the need to gain maximum space efficiency and productivity.

Each power supply is also a potential point of failure, dramatically reducing the reliability and increasing the support costs of



today's automation solutions. Plus, power supplies cost money. A typical power supply brick can add $40-50 to the cost of a product. Add to this the cost of installing extra power outlets or power runs and solution costs can escalate.

Have you looked under the counter at a fast food restaurant lately? It's not hard to understand the costs and problems associated with electronic device deployments.

Applications Affected

As mentioned above, the retail industry may be the most affected by the power supply problem. Each POS terminal has multiple devices. Usually, space is limited and in most stores, checkouts are replicated, further compounding the problem. A big box store could easily have hundreds of POS peripherals installed, each potentially with its own power supply and cabling.

Another industry affected by the power supply issue is mobile computing (e.g., delivery services, police and fire, and overland transportation). Since 110/220 AC outlets simply aren't available in a car, truck or airplane, each standard peripheral power supply presents a unique problem for deployment. Just what do you plug it into?

Vehicle power is also often provided in DC such as a 12- or 24-volt car or truck battery or a 6-volt cigarette lighter. Deploying multiple DC-to-AC converters in each vehicle is not practical for an entire truck fleet.

Powered Data Port Technologies

To solve this problem, engineers turned to a model deployed universally for telephone systems: run power over the same line as the communications.

Engineers figured out that a device's data interface could also be used to supply power to that same device. This allowed the device to send and receive data and also be powered over the same interface that was used for data transfer, completely replacing the external power supply for that device. As long as another device, often a PC, could provide sufficient power over this interface, the peripheral device could shed its power supply and its clumsy cabling altogether.

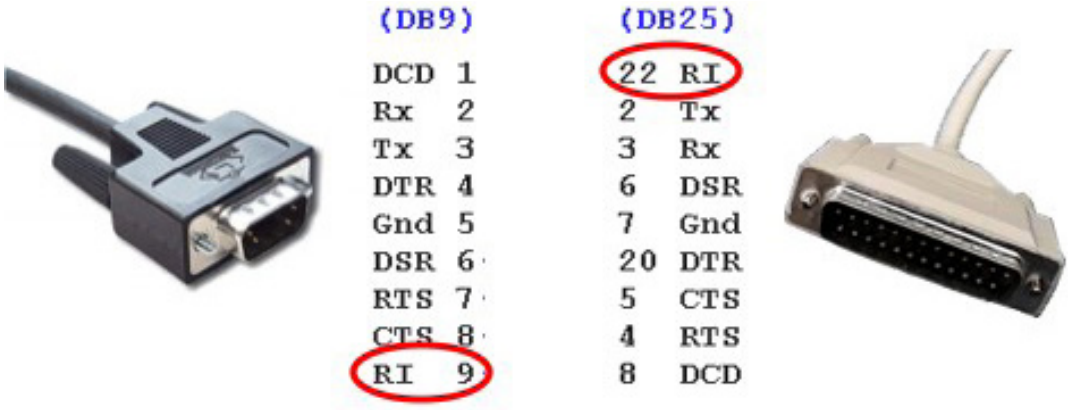
A. Powered Serial

Probably the first adoption of powered data ports came with simple serial interfaces like RS-232, RS-422 and RS-485. Since serial connectivity is easy to use and inexpensive, countless peripheral devices have used it for years for sending data and commands to and from these devices.

As is often the case for the first deployment of a technology idea, there was and is no standard for how to power a device over a serial port. In the absence of a standard but the presence of a need, major industry players developed their own approaches which gradually became accepted throughout the industry.

Since most peripheral devices in key markets like retail/POS take input power at 5 volts or 12 volts, these voltages became the norm in the design of powered serial ports. POS workstation vendors began to design in 5V or 12V powered serial ports in their workstations, in cooperation with POS peripheral vendors of products like scanners and displays. At the very beginning, this technology was promoted by workstation and peripheral vendors like IBM and NCR. Over time, however, their designs were adopted by other peripheral vendors to ease integration with the workstations of the original pioneers.

Since the serial standards like RS-232 were not designed to carry power, how was this function accomplished? In most cases it was achieved by using part of the serial standard's design that was infrequently used in the target application. For example, the RS-232 standard identifies an interface pin called Ring Indicator (RI). This pin is used for devices such as analog modems that connect to or replace telephones. If a telephone connection is not required for a device with a serial interface, it is very easy to use the RI pin to carry the device power. This is often the pin used for such a powered serial interface.



In the absence of a standard, the amount of power that may be supplied over a serial interface varies greatly from vendor to vendor and device to device. But approximately 1 amp of current over a powered serial interface is common among workstation vendors. This 1-amp current yields up to 5 watts power on a 5-volt interface or 12 watts on a 12-volt interface. Some special designs have been done for higher powered 24-volt peripherals, but these are not as common.

B. Powered USB

Standard USB
When a faster form of serial was needed, the Universal Serial Bus (USB) was designed specifically with powering in mind. The USB 1.1 standard and its 2.0 follow-on specifically define how to power devices over the same USB bus that is used for transmitting data. Because of this standardization, bus-powered USB devices have proliferated.

The power limits for standard USB are a maximum of 500 mA at 5 volts, or 2.5 watts for a single device. Although not high enough for every USB peripheral, this 2.5 watts can easily handle a wide variety of USB devices such as keyboards, mice, cameras, memory sticks and many others.

Bus power may be supplied by a host PC directly or from powered USB hubs. This allows the flexibility of using bus-powered peripherals without necessarily having to worry about the available power of the host PC. While USB hubs may also be bus-powered, the 2.5 watt limit for an entire hub makes this less common, and most USB hubs have their own power supply. That allows the hub to deliver 2.5 watts of power to each downstream port or device.

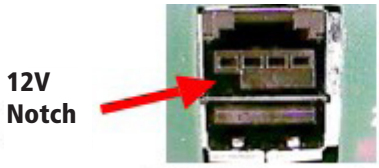
USB PlusPower
Because 2.5 watts was insufficient for some common peripherals such as printers, another standards effort was undertaken to define a variant of USB that would support higher levels of bus powering. This standards effort was driven largely by the retail industry and the peripheral and workstation vendors that served this industry. While a formal standard was never adopted, most vendors have adopted the draft USB PlusPower standard in their implementations.
The USB PlusPower standard defined a new USB connector to carry the extra power for higher powered devices. But this

connector design was done with downward compatibility in mind. The USB PlusPower connector will support insertion of a USB PlusPower cable for higher powered devices, but it will also support inserting a standard USB cable into the lower portion of the connector for connecting standard USB devices, bus powered or not.

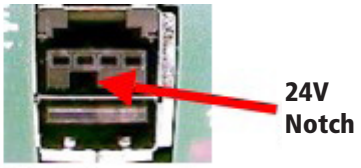
Powered USB

Standard

USB PlusPower connectors are also keyed by voltage: 24-volt, 12-volt, or 5-volt. This guarantees that an incompatible voltage connection may not be made between host or hub and device. Power limits defined in the standard are 6 Amps per connection, or 30 watts for a 5-volt connection, 72 watts for a 12-volt connection, or 144 watts for a 24-volt connection. Even the highest powered 24-volt printers are capable of being bus powered with USB PlusPower, as long as they are designed to use USB PlusPower connectors.



12-Volt Connector



24-Volt Connector

As with standard USB, bus power with USB PlusPower may be supplied either by the host PC or by a powered hub. If supplied by the host PC, care must be taken to ensure that the PC has sufficient power available to power these high power peripheral devices. An excellent source for additional information about powered USB is www.usbpluspower.org.

C. Powered Ethernet

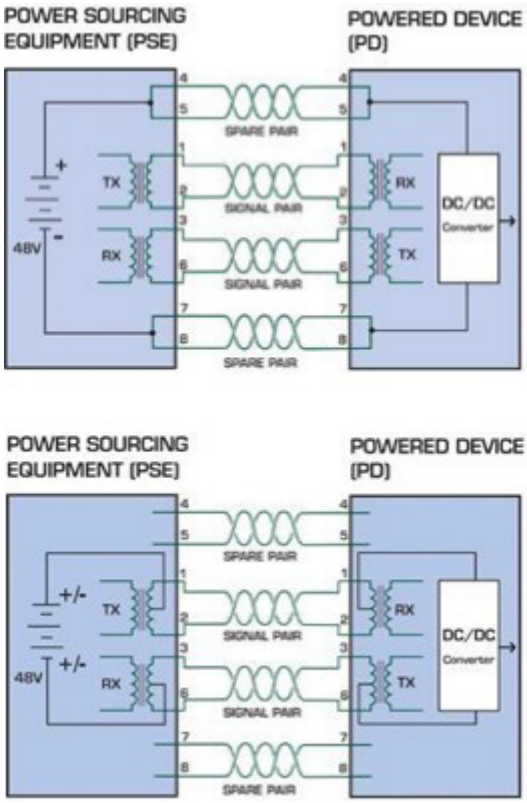
Although Ethernet has been around for many years and fully standardized by the IEEE, it wasn't until 2003 that the standard was expanded to include providing device power over the data interface. The IEEE 802.3af standard was adopted in June 2003 and specifies how such data interface powering is to be done.

Powered Ethernet, as described in the 802.3af standard, provides data and power over standard CAT3, 5 or 6 wiring. The network architecture is designed around Ethernet switches that provide both data and power. Since only two of the four CAT5 pairs are used for Ethernet data, there are two different approaches to this powering.

One, called mid-span, sends the data over one wire pair while the power is provided over the unused pair. In mid-span, the switch acts more as a patch panel, with no conflict between data and power on the wiring pairs. Since a mid-span switch takes standard Ethernet in and provides powered Ethernet out, it can be very useful for gradual network migration to powered devices.

The other approach, called end-span, provides data and power over the same wire pair. The Ethernet pairs are transformer-coupled, with DC power at the center tap of an isolation transformer. This ensures that power and data do not conflict, even though they use the same wire pair. End-span switches are more often used for new network deployments.

An optional feature of powered Ethernet is SNMP management for nightly power offs or remote resets.



The power provided with powered Ethernet is nominally 48 volts at a maximum of 350 mA or about 13 watts. 1500V isolation is also provided for safety.

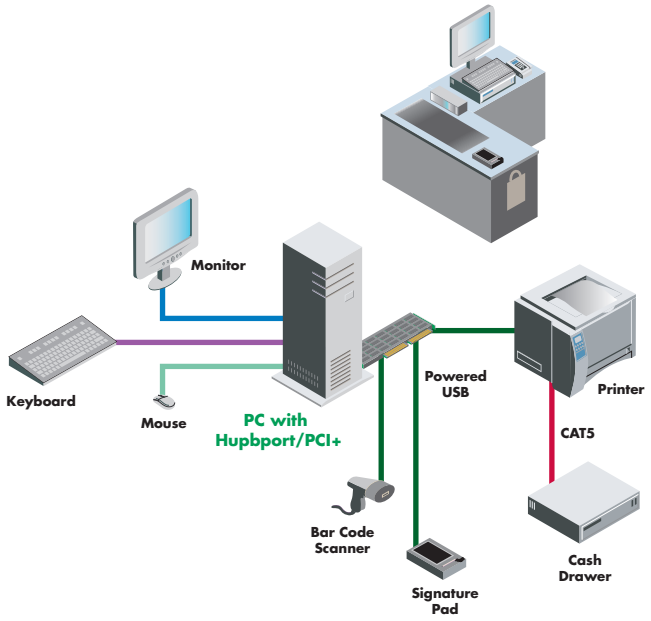
As with the other powered port technologies, if a device is to get its power from the Ethernet switch, the device itself has to be designed to accept power over the Ethernet interface. The 802.3af goes a step further than the other powered port technologies by providing a protocol between switch and device to determine whether the device is designed to accept Ethernet power. The powered Ethernet switch sends an inquiry to every device on the network asking whether they are 802.3af compliant. If no answer or an incorrectly formatted answer is received, then the device is assumed not to be capable of Ethernet powering and none is provided. If the device answers in the affirmative, then Ethernet powering is used.

An excellent source for additional information about powered Ethernet is www.poweroverethernet.com.

Deployment Examples

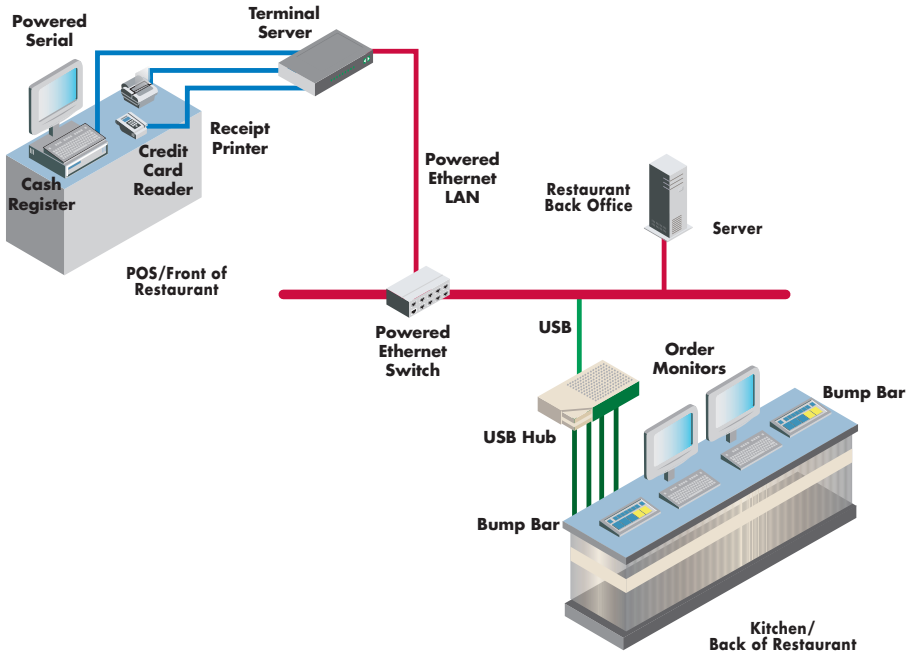
A. Retail checkout

The diagram below shows a retail checkout station utilizing USB PlusPower technology to reduce the number of externally powered devices. Note that a printer, scanner and signature capture device are all connected to a powered USB hub that provides the power and data to each of these devices directly over the same cables. Additional devices, such as a pole display and credit card reader, could be also added to the same powered USB solution.



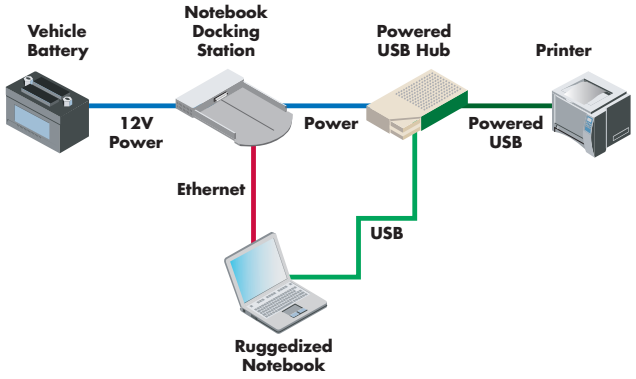
B. Fast food counter

The diagram below shows the combined use of several powered data port technologies. The powered Ethernet switch in the center of the diagram provides power to the terminal server in the front of the restaurant. This same terminal server provides powered serial to devices at the cash register location. In the kitchen in the back, a powered USB hub provides power to the order processing peripherals.



C. Delivery truck

The diagram below shows a small in-vehicle network taking advantage of USB PlusPower technology. Note that the vehicle's 12-volt battery connects directly to a notebook PC's docking station, which in turn powers a powered USB hub and a powered USB printer in sequence. This approach removes the need for separate power supplies for the printer and any other USB peripheral device in the vehicle.



Digi Products

Digi International provides a broad offering of connectivity products that support data port powering in all of the powered port technologies described in this paper.

A. Powered serial

Powered serial out
1. Digi ClassicBoard™ PCI
2. Digi Neo® Universal PCI
3. PortServer® TS P MEI

Powered serial in
1. Wavespeed®/S
2. PortServer TS P MEI

B. Powered USB

Powered standard USB out
1. Edgeport®
2. AnywhereUSB®
3. Rapidport/4®
4. Hubport®

Powered standard USB in
1. Edgeport
2. Watchport®/V
3. Watchport sensors
4. Wavespeed®/LAN

USB PlusPower out
1. Hubport/PCI+
2. Hubport/PCI+ low profile
3. Hubport/4+
4. Hubport/4c+ compact hub
5. Edgeport/42+

C. Powered Ethernet

Powered Ethernet out
1. Digi EasyPower™ (mid-span)

Powered Ethernet in
1. PortServer TS P MEI (mid-span)
2. Digi One® IAP (mid-span)
3. Digi Connect® 50 (mid-span)

Summary

The proliferation of automated devices, each with power supply bricks, cables and power strips, can take up precious commercial space, cause troublesome clutter, reduce deployment flexibility, reduce reliability and add cost to device networking solutions. Providing device power over the same interface used for data transfer can significantly reduce each of these negative effects.

Powered data port technologies exist for serial, USB and Ethernet device connections. These technologies are available today and can produce compact, streamlined, flexible, reliable and inexpensive solutions.

Digi International offers a wide variety of solutions that provide and use these powered data port technologies for easier and more effective device connectivity.

Contact a Digi expert and get started today

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