Power over Ethernet and Power over HDBaseT for Carrier Applications

White Paper

Daniel Feldman, VP Business Development and Channel Marketing

December 2014

Introduction

Since the invention of Power over LAN™ in 1998 by Microsemi, Power over Ethernet (PoE) has been employed by Enterprises worldwide to deploy IP telephony, WLAN infrastructure, Network Security Cameras and other technologies where reliability and flexibility of installation are important parameters. PoE dramatically reduces the CAPEX in existing installations where or a non-PoE switch has already been deployed or in those where the devices are located in hard-to-reach locations. Turning power into smart power, PoE also allows OPEX reduction through powering devices down in pre-scheduled times, and through remote device scheduling.

While tackling challenges not always identical to Enterprises, Service Providers face similar issues related to device location (and the presence of AC) and centralized device backup.

This whitepaper provides a brief overview of the existing Power over Ethernet and Power over HDBaseT standards, and how PoE and PoH can be used by Service providers in different wireless and wireline access applications.

Power over Ethernet: technology and standards

PoE Technology

Power over Ethernet is, generally speaking, a technology that allows sending power and data over the same Category 5 (or better) cables, at a range of up to 100m (333ft). It includes a compatible device detection mechanism, which means only those will be powered. The operating voltage for energy transmission is always under 60V, power is always under 100W, and the power source is protected against short circuits. With that, PoE is safe for people and for equipment. PoE's major advantages over using a local AC power adaptor are:

a) The Powered Device (PD) can be located anywhere in a radius of 100m from the Power Source Equipment (PSE)
b) The PD can be remotely reset, without the need to access it physically (with a managed PSE)
c) All the PDs connected to a single PSE can be backed up with a single Uninterrupted Power Supply (UPS), instead of having a UPS per device
d) The RJ45 connector is universal, the same in every country
e) PoE PD devices can be shutdown remotely for extended periods of time (with a managed PSE)

The PoE Standards

The original PoE standard, IEEE802.3af-2003, defined the method of delivering safe power to devices consuming up to 12.95W. In September 2009, the IEEE802.3 working group finalized IEEE802.3at-2009 specification, which defined delivering up to 25.5W to Powered Devices over 2-pairs, and allowed the delivery of up to 51W to a device over a single Category 5 or better cable (without clearly specifying how). The IEEE802.3bt task force is working to clearly define the delivery of power above 25.5W over 4-pairs.

Power over HDBaseT

HDBaseT is a standard created by the HDBaseT Alliance that includes 5Play™, enabling up to 8 Gbit/s of uncompressed video and audio, 100BaseT Ethernet, control signals and power to all share the same cable, across distances up to 100m using standard RJ-45 connectors. Geared towards connecting Audio and Video Equipment, HDBaseT addressed the need for delivering even more power, as TV's will often take over 51W.

Power over HDBaseT (PoH), ratified in September 2011, extends PoE's capabilities to deliver up to 95W over CAT5e and better cables. The HDBaseT Alliance has chosen the Microsemi 4-pairs detection methodology to insert power while enabling lower cost and higher energy efficiency at lower power levels.

Midspans vs Switches

There are two ways to deploy high-power PoE technology: by upgrading the network switch, or by installing Midspans in the existing networking infrastructure. PoE-capable switches offer the advantage of an integrated solution that requires only one cable for the network connection. However, this isn't necessarily the best choice. Unless shortcomings of existing data network infrastructure requires replacement of the switch to provide increased capacity or performance, and is required for low-power levels, Midspans are the superior choice for PoE deployment. They deliver a combination of simplified deployment, management and maintenance, with superior flexibility, reliability, security and energy efficiency. By decoupling the power and data portions of the network infrastructure, Midspans simplify network expansion and upgrades, and provide more flexibility for low-port count incremental upgrades to the power infrastructure.

Carrier Applications deployment with PoE and PoH

There are multiple carrier applications that can benefit from PoE or PoH technology. The sections below enumerate different configurations

Indoor Enterprise or Public Space Small Cells and Wi-Fi Hotspots

Small cells are typically deployed at high, hard to reach locations, for coverage reasons. Typically their power consumption is between 10W, for voice short range femtocells, to 50W for higher range, higher bandwidth cells, which may include IEEE802.11ac support. These small radius cells are normally connected to the network through 1000BaseT (Ethernet over copper). In the extreme case where an enterprise femtocell needs to provide 100Mbit/s bandwidth to more than 10 users at once, a 2.5Gbit/s link such as NBase-T or 10GBaseT uplink can be used.

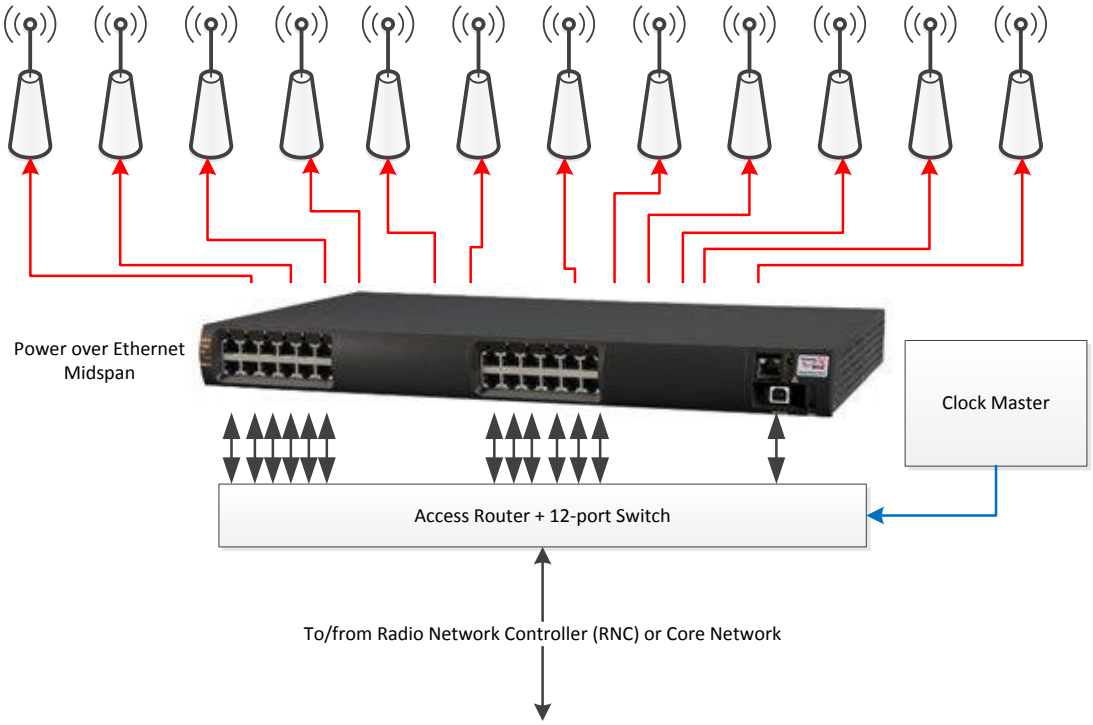

Figure 1 Small Cell Cluster Deployment with PoE

PoE based deployment allows convenient location and simple installation using the Ethernet infrastructure for both data and power transmission. Managed PoE also allows remote power management including power monitoring, remote reset and shutdown at pre-defined schedule to allow power savings and optimization of power usage. In the cases where management is desirable, the capability to support IPv6 and SNMPv3 are present. The fact that a single PoE Midspan or Switch is to be utilized to power devices that provide contractual service to customers makes it desirable to have support for redundant power supplies.

Deployment of networking equipment owned by carriers in locations which are not owned by them makes it extremely important to consider the question of network demarcation and deployment. Many enterprises already have WLAN Access Points connected to PoE Switches. The deployment of small cells at the same location adds cellular coverage and increases Wi-Fi bandwidth, however it requires a drastically higher amount of power consumption leading to the question: can it be done with the PoE switch? The existing PoE switches would in most cases support 15.4W only, and in some cases 30W. Replacing the switch is complex, as the switch is owned and maintained by the IT manager responsible for the location. So the ideal solution is a Midspan, which can be added to the network without disruption or reconfiguration of existing switches.

PoE as part of the Infrastructure

An additional advantage of PoE Midspans is granularity/separation: Midspans are available in 1, 4, 6, 12 and 24 port configurations, and can be:

a) Paired with a switch with a larger number of ports
b) Shared between two switches

This means that PoE is only purchased when really needed, and the PoE refresh cycle is de-coupled from the Ethernet Switch refresh cycle. With a Limited Lifetime Warranty of 16 years for Microsemi's Managed Indoor Midspans, this means completely skipping a refresh cycle. Effectively, PoE becomes part of the cabling infrastructure.

Energy Efficiency and PoE

Deploying PoE only when needed is also more energy efficient. If PoE switches with PoE on every port are deployed and not fully populated, the PoE power supplies inside the switches will have a lot of idle capacity, which means higher power losses from the moment the PoE switch is installed. PoE Midspans allow installing PoE only to the devices that need to be powered, minimizing standby power losses.

Microsemi's PD-55xx, PD-95xx and PD-96xx series include a Microsemi-exclusive technology, EEPoE™ (Energy Efficient PoE), which further reduces power dissipation by utilizing all the copper available in a CAT5 (or a better cable) to deliver power to IEEE802.3at 25.5W (or below) devices. With EEPoE, power dissipation on the cable is cut by up to 2.25W per port, compared to other Microsemi PoE Midspans.

Outdoor Small cells or Wi-Fi Hotspots

Outdoor cells are located in places without easy access to electricity, and have the added disadvantage of requiring IP66 or IP67 weather protection, which means that minimizing the number of input ports is critical. Once more, PoE can be used to deliver power, either:

a) From a Fiber Backhaul gateway with PoE capabilities
b) Through the utilization of an outdoor Midspan
c) Using a single port Midspan located indoors, at under 100m from the Small Cell or Wi-Fi Hotspot
d) Using an outdoor rated PoE hub (connecting and powering Small Cell + Backhaul or IP Camera + Wi-Fi Mesh Hotspot)
e) A managed PoE switch, which would connect between the multiple outdoor PoE devices such as IP camera + Small Cell + Wireless/Fiber Backhaul, or IP Camera + Wi-Fi Hotspot + Backhaul

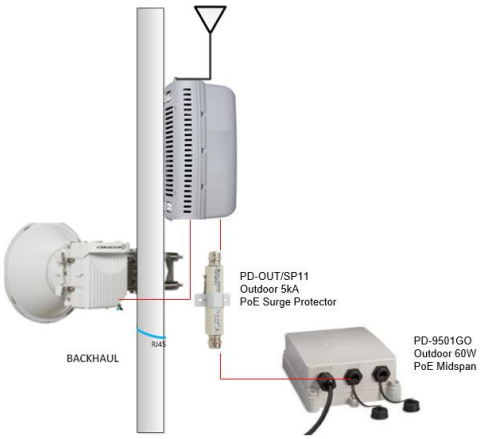

Figure 2 deploying a power forwarding Small Cell + Backhaul with an outdoor Midspan

Figure 3 Indoor to Outdoor Small Cell/Wi-Fi Hotspot Deployment

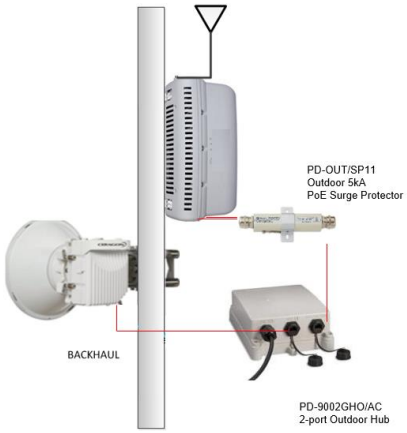

Figure 4 Small Cell + Backhaul Deployment with PoE Hub

Figure 5 Wi-Fi Mesh Hotspot with IP Camera Deployment with Managed PoE Switch

Legacy small cells or backhaul devices may have a separate DC input operating at Telecom voltages, developed before the availability of PoE+ and PoH. This would be an additional input, and therefore not efficient from the cost and design complexity, and is slowly being abandoned by small cell manufacturers.

In outdoor installations it is critical to ensure that a proper surge/lightning protection device is placed close to the device being powered, to protect the device. This is especially important in case there is a long cable run between the outdoor PoE PSE (typically internally protected) and the Powered Device.

Outdoor cells can also be connected to an indoor communications room, in which case the lightning protection needs to be installed close to the building Ethernet outlet, and the indoor PoE power source employed should be a single port device. According to IEEE802.3-2012 Clause 3.3.4.1.1 Electrical Isolation Environments, multiport PSE devices cannot be used to power devices placed in two different buildings. This is to protect one device from the other, in case a device is not connected to surge protection, and to protect indoor devices from surges that come from outdoor.

With outdoor deployments, it is also important to consider heating and cooling requirements, which typically increase power consumption potentially up to 70W, which is in the PoH range but not in the PoE range.

The First Mile

Power over Ethernet/ HDBaseT can also be used to power outdoor modems used to create the first mile of connectivity service given to a customer. This becomes relevant in three cases:

a) A Fiber to the Home (FTTH) carrier does not have access to the Customer Premises
b) The service is wireless (LTE, WiMAX, Wireless Broadband) and requires an outdoor client
c) Satellite Service with SAT>IP, which defines an IP LNB with PoE connectivity

In all cases the outdoor client can then be powered from inside the building through either a home gateway with built-in PoE capability (rare), or a single port Midspan. Lighting protection is necessary, and preferably installed as a separate device outside the home or office, as close as possible to the Ethernet cable inlet, and connected to grounding.

Fiber to the Distribution Point (FTTdp)

While FTTH provides extremely fast internet access to subscribers, bringing fiber all the way to the home is in many cases cost prohibitive. And VDSL2 links, used to compete with Cable, are not nearly fast enough (250Mbit/s vs 10Gbit/s). G.FAST is the ITU-T answer to cable, bringing up to 1Gbit/s over twisted pairs, at distances of up to 400m. The new issue brought by G.FAST's reduced loop size is the that statistically the number of customers serviced by a single DSLAM is going to be much smaller than on VDSL2, which can have loops of several kilometers. And bringing power to each of these DSLAMs, located at the Distribution Point (a.k.a. Distribution Point Units, or DPUs) becomes an issue.

The solution to that problem comes in the form of Reverse Power Feeding (RPF) over xDSL. With reverse power feeding the power is fed from the customer premises to the DPU, greatly reducing the installation cost. The DPU is responsible for sharing power coming from the different subscribers in a fair manner.

PoE and RPF are not the same. PoE, as mentioned before, is an IEEE802 technology, working in Ethernet cables. RPF is being defined by the Broadband Forum and by ETSI.

RPF Standard

The RPF standard currently allows sending up to 21W of power over 2-pairs, either from a home gateway or from an RPF injector. The amount of power available at the DPU depends on the quality of the twisted pairs cable used, and on the distance between the subscriber and the DPU. Voltages are SELV, or under 60V, for safety purposes.

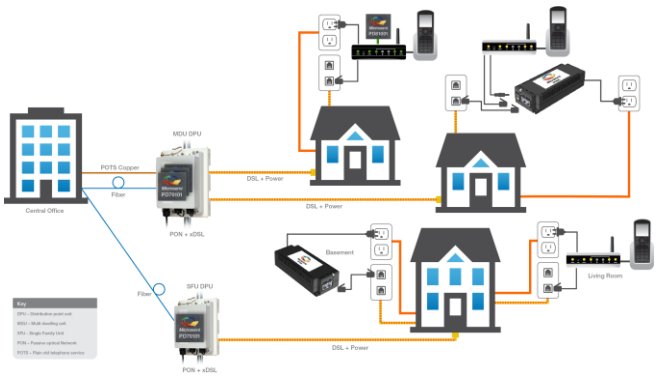

Figure 6 Reverse Power Feeding for Fiber to the Distribution Point

Microsemi PoE Systems

Microsemi has an extensive Gigabit PoE System product portfolio including:

a) Single port Midspans delivering 15.4W to 95W, for indoor-to-indoor, indoor-to-outdoor and outdoor-to-outdoor deployment
b) 2-port PoE Hubs with 30W per port for outdoor deployment
c) 3-port PoE Managed Switches with 30W per port for outdoor deployment
d) 4-port Unmanaged PoE Midspans with up to 30W per port
e) 6-port, 12-port and 24-ports Managed PoE Midspans with up to 95W per port, redundant power supplies, mutual Midspan backup and Energy Efficient PoE (EEPoE)
f) Outdoor Lightning Protection for device for Ethernet Solutions

Microsemi PD Certification Program

Microsemi offers a free-of-charge certification program to its partners, in which partners are certified to interoperate with Its PoE Midspans and Switches. Approved devices are placed at the PoE PD certification list at http://www.microsemi.com/products/poe-systems/poe-compatible-devices.

Summary

Power over Ethernet, Power over HDBaseT and Reverse Power Feeding over xDSL can greatly ease the deployment and maintenance of carrier technologies such as Small Cells, Backhaul, Wi-Fi, Wireless Broadband, FTTH and FTTdp. Microsemi has a complete PoE/PoH product portfolio, allowing the usage of data infrastructures to deliver power as well as data in indoor and outdoor environments. Microsemi also offers an Innovative High Reliability Outdoor Lightning Protection Device for Ethernet Solutions to increase the resiliency of indoor infrastructures connected to outdoor devices.

Microsemi's PoE Midspans can make the addition of Power over Ethernet seamless, without the need to replace existing Ethernet switch infrastructure, and by separating large power supplies from sensitive Ethernet equipment.