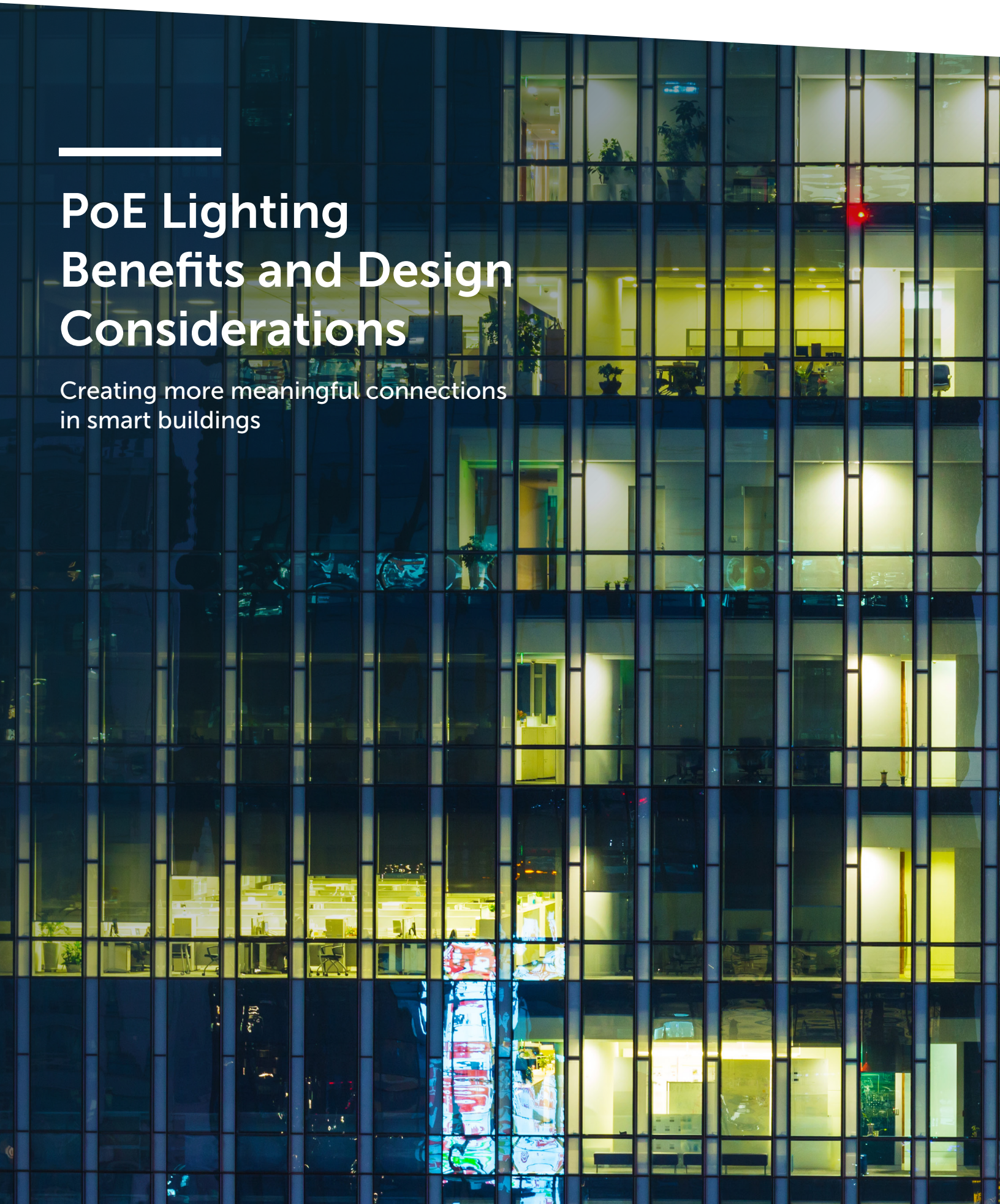

PoE Lighting Benefits and Design Considerations

Creating more meaningful connections
in smart buildings



Introduction

Smart devices, smart cars, smart grids, smart cities. More meaningful connections are being made to enhance every aspect of our lives and buildings are no different. Smart Buildings include the convergence of heating, ventilation, and air conditioning (HVAC), building automation, lighting, and other facility-based systems.

Traditionally, most buildings have separate networks for the devices that operate the building automation, HVAC, access control, and lighting systems. However, managing these separate networks can be difficult and cumbersome. New technologies are creating the possibility of creating a single converged smart building network. In theory, this would remove the complexity of operating several facility-based networks.

Power over Ethernet (PoE) lighting is at the core of this smart building revolution. PoE lighting merges technological advances in low voltage (DC) LED lighting with technological advances in PoE IP networking. The connection of these advances creates an exciting Building Internet of Things (BIoT) component and could provide significant cost savings and unforeseen benefits to the way we work and live.

Why PoE?

PoE is a standards body approved technology that has been around for quite some time. It safely allows electrical power and data to transmit concurrently on a single twisted-pair cable (Category 5e or above). Over the last 14 years, several standards bodies now provide for 15.4 W (PoE), 25.5 W (PoE+), 60 W (PoE+), and soon 100 W (PoE++). Many technologies today are using PoE to power devices. Connecting new devices to the network is as simple as plugging them into an RJ45 jack. Some examples of PoE-enabled devices are Voice over IP (VoIP) phones, Wireless Access Points (WAP), and security devices.

Some benefits of a PoE network are:

- Powers devices on the same network used for data communications
- Easier installation
- Cost effective installation
- Easier network management
- Uses smart power technologies
- Uses DC power
- Higher reliability
- Higher power transfer efficiency
- Ability to perform power/energy management

Benefits of PoE Lighting

One of the biggest uses of energy in a typical enterprise building is the lighting. The energy savings from the use of LED lighting is well documented. Recently businesses have transitioned from incandescent to fluorescent lighting. This shift along with falling prices and a proliferation of products have triggered a rapid market adoption of LED lighting. LEDs are driving a dramatic change in lighting due to their vast energy savings potential, longer life, and maintenance savings. Other features of LEDs include wavelength (i.e., color temperature) for circadian rhythm optimization, color and/or flashing to indicate emergency pathways, and constant light (not 60Hz modulated that leads to eye strain).

Network-powered lighting systems can be the centralized hub for a smart building's converged, all IP network. A centralized hub provides a single network bringing together lighting, Internet of Things (IoT) devices, sensors, building automation, HVAC, analytics, and other technologies. In the same way that VoIP drove exciting new changes to enterprise telecommunications networks, PoE lighting can be the defining platform that enables new capabilities.

In a connected PoE system, each light links to the building's IT network. The system can drive new ways to interact with people and places, sense the environment, gather and share data, and provide a more productive and enjoyable working environment. Lighting fixtures can become the focal point of an all IP network delivering intelligence, gathering and sharing data on occupancy, activity patterns, temperature, daylight levels, and other data. The flexibility of an all IP network helps to future-proof your investment and emerging applications can use this data to deliver exceptional value to users and building managers.

LED lighting systems have the benefits of longer expected operating life, reduced energy consumption, better color rendition, and dimmability. Also, there is less hazardous material to deal with at the end of life. Some PoE lighting can provide live usage data or can keep records of usage to help decision making about future lighting needs. Using LED lighting as the network backbone of an all IP network integrates intelligent control systems, enabling a host of new capabilities and an upsurge of low voltage devices in the building. The price of LED lighting continues to drop and is now comparable to legacy lighting technologies. Facility managers and decision makers are considering these factors when replacing or purchasing new lighting.

In a recent case study of The Edge¹, an innovative multi-tenant office building in Amsterdam built for Deloitte, the goal was to create an intuitive, comfortable, and productive work environment for employees, save energy, and future proof the building through the ability to add sensors and locator beacons. Using LED lighting and PoE, the study showed a 33% cost savings per employee while improving the work environment and providing a lighting based PoE network for future leverage. The benefits of an IP network infrastructure designed to support lighting, power, data monitoring, and building controls over a single flexible system include:

- Collect data from whole facility, specific zones, or individual spaces
- Higher efficiency, increased safety, increased comfort, and lower cost of facility operations
- Improve real estate use to decrease costs and improve workforce productivity
- Reduced infrastructure and installation costs
- Opportunity for LiFi

Zone Cabling for PoE Lighting

Zone cabling is a standards-based, structured cabling strategy where all system networks are converged within common pathways from the telecommunications rooms (TRs) to consolidating points. This strategy is well-positioned to enable PoE lighting deployments. This section raises areas to consider before deploying a PoE lighting network within a zone cabling architecture.

Zone cabling designs focus on bringing consolidation points or small "quasi" TRs closer to the end user, or in the case of PoE lighting, to the end use. This reduces the need for "homerun" horizontal cabling that goes from the end use/user back to the TR. The zone cable design strategy increases the flexibility of the cabling infrastructure while decreasing the complexity of homerun cabling. These consolidation points can be in wall-mounted zone enclosures, in-ceiling zone enclosures, or under-floor mounted enclosure boxes. Zone cabling enclosures are easily accessible for moves, adds, and changes (MAC). Panduit is uniquely positioned to assist with both zone cabling and PoE lighting, having extensive experience with both technologies.

¹ Philips. (2017). Connected Office Value Beyond Illumination [PowerPoint slides].

PoE Switches - Centralized vs. Distributed

There are two deployment strategies for PoE lighting installations. The most common strategy is a centralized deployment (Figure 1) where the PoE switches are centrally located in the TR. From the TR, copper cable runs to a patch panel within the zone enclosure, then from the patch panel to the lighting troffers. Table 1 lists the advantages and disadvantages to this style of deployment.

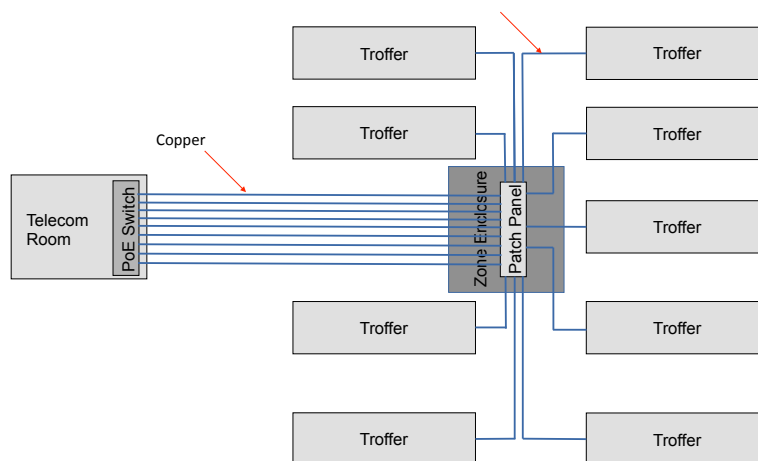


Figure 1: Centralized PoE switch zone cabling deployment.

Centralized Advantages	Centralized Disadvantages
Uses existing power infrastructure	Requires more cabling
Centralizes active equipment	Distance limitations from TR limited to 100m or less
Easier to perform maintenance on equipment in TR	Larger PoE switches are generally less cost-effective

Table 1: Centralized PoE Switch Zone Cabling Advantages and Disadvantages.

The distributed strategy results from newer, smaller PoE switches designed for a distributed architecture (Figure 2). The PoE switch is in a zone enclosure, usually in the ceiling, closer to the lighting troffers. This allows for lighting troffers to be at greater distances from the TR and uses less cable. The uplink from the TR to zone enclosure box can be fiber or copper. Fiber connections allow for greater distances. Table 2 lists several advantages and disadvantages to a distributed architecture.

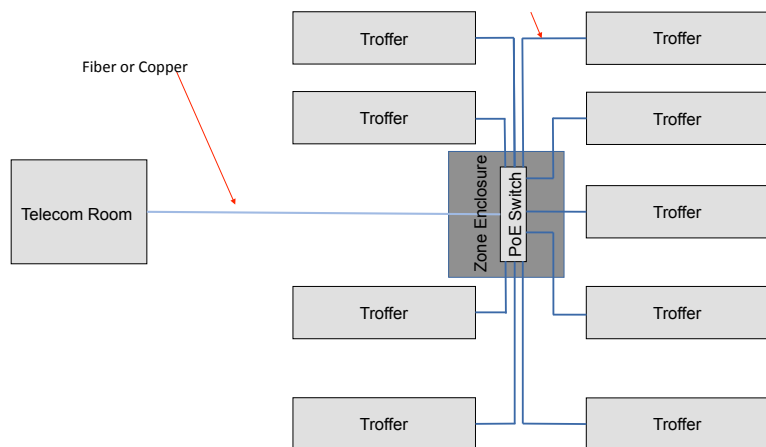


Figure 2: Distributed PoE switch zone cabling deployment.

Distributed Advantages	Distributed Disadvantages
Requires less cabling	More difficult to perform maintenance on equipment in ceiling box/zone enclosure
Distance is less of a limitation	Decentralizes active equipment
Smaller PoE switches are generally more cost-effective	New power infrastructure needs to be run into the ceiling

Table 2: Distributed PoE switch zone cabling advantages and disadvantages.

Directly-Attached Architecture vs. Node-Centric Architecture

Traditionally, direct-attached architectures (Figure 3) have been employed for PoE lighting deployments. This means that there is a one-to-one relationship between PoE lighting units, switches, and any other items attached via PoE to PoE ports on a switch. For as many PoE powered items attached to the network, there should be an equal amount of PoE switch ports on the switch. This can get expensive due to the cost per port of a PoE switch. Also, depending on the switch size, adding a PoE item could become expensive due to the necessity of purchasing an additional switch for the PoE port for that item.

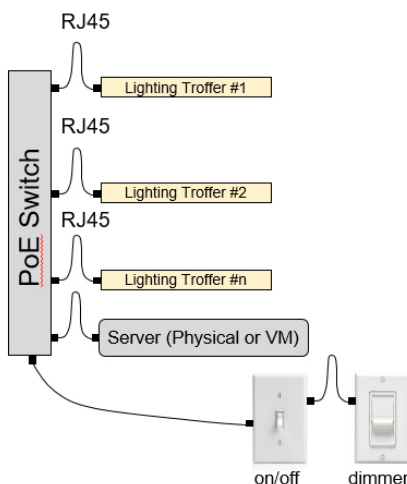


Figure 3: Directly-attached architecture.

Node-centric architectures allow for many items to be attached via one PoE switch port through a node. In Figure 4, the node is connected via RJ45 copper cable. From the node, four canned lighting units are connected via 18-22 AWG low-voltage electrical cabling. Only one PoE switch port is consumed, and four lights are powered.

There are some limitations for node-centric architectures. Currently, a UPoE switch port (60 W per port) can power only four canned lighting fixtures or one full 2x4 lighting troffer. This architecture could work well if you have quite a few canned lighting fixtures in your deployment.

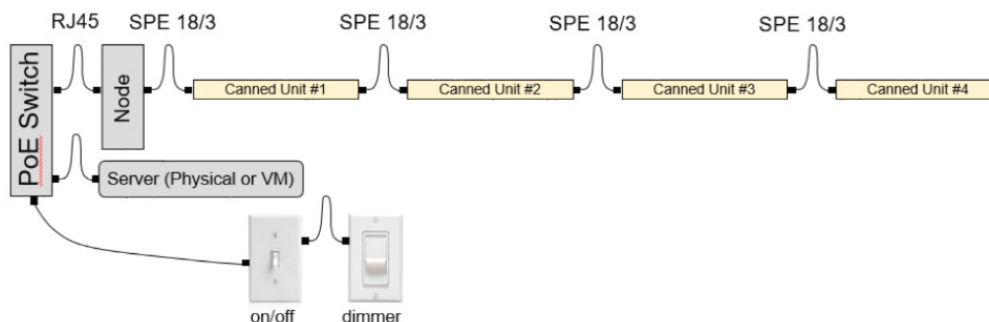


Figure 4: Node-centric architecture.

Converged vs. Separate Building Automation and Lighting Networks

Traditionally building automation networks have been operated by a separate, dedicated network. Building automation networks have also tended to be controlled by Facilities/Operations Teams with little to no IT involvement in the day-to-day operations of the network. With the introduction of PoE lighting, some of these traditional arrangements must transform to better accommodate the requirements that PoE lighting can apply to a network.

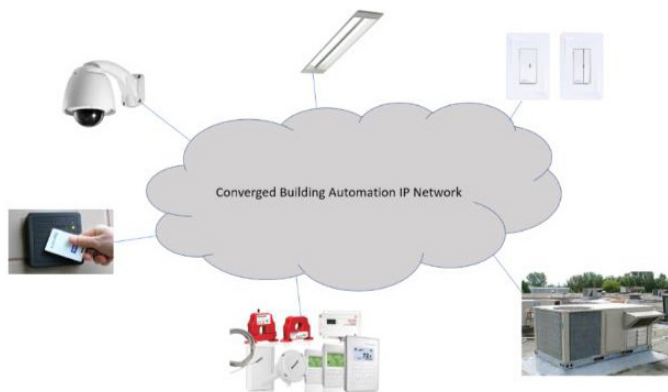


Figure 5: Converged building automation IP network.

Building automation networks provide services such as access control, security cameras, and environmental sensors. Whether to converge these services with the lighting network (Figure 5) is a choice that must occur prior to installing the PoE lighting network. Table 3 and Table 4 list the advantages of both separate and converged networks.

Note: Converging the enterprise LAN into the building automation and lighting network is not suggested.

Separate Network Advantages	Separate Network Disadvantages
Uses existing and proven technology	Requires more cabling
Traditionally the way things have occurred	More difficult to manage two separate facilities networks

Table 3: Advantages and Disadvantages of Separate Building Automation and PoE Lighting Networks.

Converged Network Advantages	Converged Network Disadvantages
Requires less cabling	Uses new and less proven technology
Easier to manage one network instead of two	Changes normal operations

Table 4: Advantages and Disadvantages of Converged Building Automation and PoE Lighting Networks.

Several requirements must be met to successfully converge a building automation and PoE lighting network. First, all building automation components must be IP-based or can be connected to an IP network through an adapter or converter. Second, the installed network cabling must be capable of handling PoE (generally 28 AWG – 22 AWG twisted pair copper cabling). Finally, to gain the full value of a converged building automation and PoE lighting network, a single pane of glass management software package would be required.

Conclusion

LED lighting powered by PoE will be one of the most meaningful developments in our indoor environments over the coming years. Benefits include increased energy savings and lower deployment costs, along with simplified installation, flexibility, and improved reliability for powered devices. These enhancements greatly contribute to overall effectiveness and efficiency that directly impact the performance of next-generation smart buildings.

A company must make a multitude of deployment decisions once it chooses PoE lighting. This technology brief helps to identify some of these decisions. It also provides some assistance to making informed choices by providing advantages and disadvantages of each choice. In summary, this paper clearly shows the opportunity to improve efficiency offered by converging building automation and PoE lighting networks.

DISCLAIMER: This Technology Brief is for informational purposes only. Each customer should evaluate its own requirements prior to determining the POE deployment strategy that best fits its needs.



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