Commercial building developers and owners are exploring ways to optimize workspaces, boost productivity and improve energy efficiency. Integrated technologies in Power over Ethernet (PoE) distributed networks have become a powerful force for transformative building designs.

BY GIOVANNI FREZZA, GROUP PRODUCT MANAGER, MOLEX

One of the most promising technologies allowing IP convergence for building automation networks, PoE distributed networks deliver electrical power and transmit communication signals over standard low-voltage category cabling to various endpoints, including LED lighting, HVAC controls, cameras and other local networked devices. PoE distributed networks offer high availability for power, guarantee uninterrupted service and lower operating expenses by providing network resiliency at a lower cost by consolidating backup power.

‘SMART’ LIGHTING SET THE STAGE

The need of ‘smart’ lighting in commercial buildings set the stage for PoE distributed networks. LEDs require low-voltage DC power in contrast with older lighting sources, which utilize AC power. Distribution of power and data on low-voltage cabling is possible using the same category infrastructure deployed by the IT industry. Delivering significantly improved light quality, with smoother intensity and dimming functions, and dynamically adjustable color temperature, LEDs are versatile, efficient, secure and able to support available wattages in PoE networks.

PoE LED lighting requires the low-voltage power distribution and data communication backbone for control. Each PoE node receives a unique IP address, allowing integration of LED fixtures, sensors and other devices with other building automation systems. Powered with a simple RJ45 connector, lights, sensors and other devices become intelligent and are faster to deploy by eliminating the need for an electrician to line voltage infrastructure, rework wiring and install power outlets at every endpoint.

By adapting to mood, task and ambient lighting, PoE LED lighting systems can be used to customize the user experience using direct, indirect, ambient and decorative schemes in a dynamic and purposeful control. LED luminaires with bio-adaptive functionality can mimic natural daylight by gradually changing from cool temperature, high intensity in the morning to a warmer, less intensive light later in the day. Subtle changes in lighting intensity provide a more natural work environment that fosters higher productivity, while optimizing energy savings through sensor feedback.

PoE distributed networks also support trends in scalable densification, with more efficient and functional workspace layouts than traditional cubicles or offices. Networked light switches, Wi-Fi and device charging stations, video, teleconferencing and presentation equipment for sharing laptop and mobile device content can accommodate staff collaboration. Control over PoE allows rapid changes in device parameter settings and zone programming simply by reassigning devices and sensors depending on space utilization needs.

Sensors located throughout a commercial or office space, often embedded in LED lighting fixtures, can collect and feed data to a central host server to report and measure air quality, temperature, occupancy and real-time energy consumption for improved operational control and efficiency. Aggregate data collected over time translates into business insights informing space utilization and flow patterns, dynamic conditions within specified areas, and how different spaces, floors, or buildings compare in terms of utilization, energy usage and productivity.
STREAMLINED CONSTRUCTION AND RETROFIT

A PoE distributed network infrastructure can add significant value for building developers, owners and occupants. By eliminating the need for a dual infrastructure, one to distribute power and another to provide communication, data and control on low-voltage cables, new construction and deep retrofits are simpler and faster than traditional AC/DC lighting and building automation systems. Although most installed control systems today are based on proprietary solutions, leading technology suppliers and the commercial building industry are trending toward use of open standards to simplify the installation, configuration and commissioning of new PoE platforms that allow power and data on the same low-voltage cable infrastructure. IEEE802.3 standards define PoE networks, specifying the physical and data link layers for wired Ethernet networks, power sourcing equipment and devices using two-pair or four-pair connections to transmit power. The original PoE standard (IEEE802.3af) based on 15.4W per switch port of power has increased to 30W in PoE+ (IEEE802.3at) using a two-pair power transfer format. Newer standards use a four-pair power transfer format designed to support 60W (UPOE) and over 95W (POH) per switch port. UPOE technology utilizes all four twisted pair. A PoE gateway physically connects and powers luminaires, sensor nodes, wall dimmers, and other local devices to the control manager. A growing variety of sensors and devices can be powered by a PoE gateway and deployed as modules or integrated with lighting fixtures. In some applications or cases, PoE can be bridged to wireless technology. For building automation and digital lighting a sub GHz wireless technology is well suited. Wireless devices such as wall switches and dimmers can use energy harvesting technology to communicate wirelessly with the PoE Gateway, without even requiring batteries or other sources of local power. After power negotiation and establishing a secure connection between the gateway (Powered Device) and a network switch (Power Source Device), a node can distribute power and data to the local devices. When devices are powered and connected they can be controlled and can provide granular data for reporting and advanced data collection for aggregate building analytics. For a purposeful and holistic control of zones, spaces, floors and the entire building, lighting is based on software controls. Software tools should provide support during the complete lifecycle of a networked lighting control system, from design and installation to live operation and building maintenance.

The right design tools can enable configuration of a building’s lighting system prior to on-site installation. Interactive floorplan views, predesigned light-scenes and a drag-and-drop interface can allow for fast layout of sensors, building lighting policies and user zones. Advanced planning and field tools simplify commissioning and on-site testing with some systems using smart devices for convenience. From an operational standpoint, facility managers depend on software control for a bird’s eye view of an entire building, with live monitoring and status updates, error reporting and sensor feedback, including system troubleshooting with immediate access and control of any zone.

A Transcend UPoE Gateway. The device is capable of 60W output and distributes power and data to lights, sensors and other low-voltage devices on the network.

CAT CABLEING - IT INDUSTRY GOLD STANDARD

Technologies used in PoE networks are well defined by the industry in the IEEE802.3 standards, which specify the physical and data link layers for wired Ethernet, power sourcing equipment and devices using two-pair or four-pair connections to transmit power and create a link to exchange data. A PoE distributed network operates across low-voltage category cable using the same proven infrastructure that the IT industry has deployed for over a decade. CAT5E cabling over copper twisted pair was specifically designed to support GbE (Gigabit Ethernet). Each of the four pairs in the cable support bandwidth of 25 MHz (100 MHz total) to transmit 1,000 Mbps. CAT6 cabling supports the 1000BASE-TX protocol enabling GbE over two pairs instead of four, supporting 100 MHz (200 MHz total) and adding a little headroom of 50 MHz. While CAT5E cable is the minimum that can be specified for a PoE network system, CAT6 23-gauge cable is recommended as best practice in new installation.
Rapid growth in the use of wireless devices is driving up demand for wireless access points (WAPs) in commercial spaces, which is a consideration when specifying category cabling for a PoE distributed network. Medium speed Ethernet protocols – 2.5 BASE-T and 5G BASE-T – support the use of legacy CAT5E and popular CAT6 category, which offers the ability to minimally double speed—or multiply up to five times—allowing the use of high-end WAPs and supporting new generations of switches. CAT6 supports both standards, whereas CAT5E is dedicated for 2.5G, although it can also support 5G but with limitations.

PoE lighting CAT cable infrastructure is mainly driven by cost and power distribution performance more than speed and data bandwidth. For this reason, lighting control and other building automation systems do not require shielded, expensive and high performance data transmission CAT cables.

Power losses over a low-voltage cable infrastructure can be reduced by using a heavier gauge cable and a proper horizontal cable infrastructure design. In general, the recommended maximum cable bundle size is no more than 98 cables to keep heat within an acceptable range. The power must be reduced if temperatures exceed pre-specified limits. The longer the distance where cables are bundled, the more difficult it is to achieve requirements of the new protocols.

Shielded CAT6A cabling is not necessary for PoE lighting and building automation systems as CAT6A and above are often used in high-end WAPs exceeding 1G. While more costly than CAT5E cable, CAT6A can support 10G protocol up to 100m without limitations, with bandwidth frequencies up to 500 MHz, and is compatible with PoE and PoE Plus standards.

POE CREATES VALUE IN COMMERCIAL SPACE

A well-implemented PoE distributed network can deliver substantial value in commercial buildings and enterprises, including:

- Well established and scalable Ethernet standards
- DC power ideal for LED and sensor applications
- Eliminates dual-layer infrastructure for power and signal
- Power and signal over single-layer infrastructure uses standard category cable
- Easy to install endpoints using low-voltage standard RJ45 connections
- Advanced control of tunable LED luminaries and dynamic/bio-adaptive controls
- High availability uninterrupted power service and network resiliency

In a recent report, Navigant predicts the global market for PoE lighting to expand more than tenfold from between 2016 and 2025. They cite energy and cost savings as key factors that will drive market growth. By eliminating the need for power conversion, PoE provides a clear path for higher energy efficiency and innovative lighting technologies with embedded sensors for building automation and analytics. (Source: Navigant PoE Market Research Report, https://www.navigantresearch.com/research/power-over-ethernet-lighting)

The tools exist to efficiently scale a PoE distributed network lighting and automation system to almost any space size or configuration. Large-scale distributed network pilots and full-scale deployments are becoming increasingly common. Optimizing the low-voltage cable infrastructure to deploy power and data in more convenient ways requires hybrid technologies, including PoE and distributed power conversion, and strategies to limit power losses. Molex and its partners bring extensive expertise in the technologies and design of PoE connectivity and cabling architecture to assure efficient network deployment.