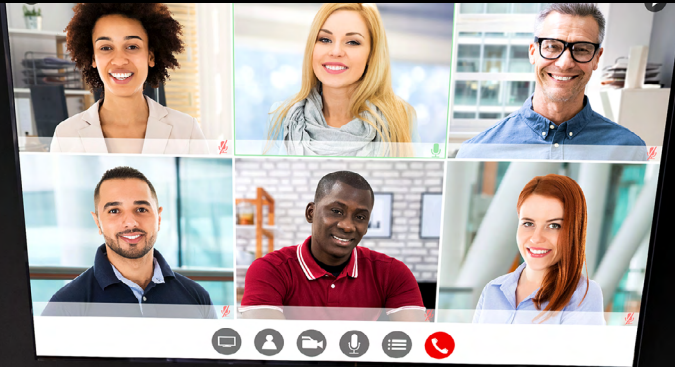


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Network-Connected Lighting Provides Smart Innovation for Next-Generation Office Buildings

By Giovanni Frezza

Digital connectivity is the backbone of modern “smart” innovation. Buildings, serving as the bedrock of developing smart cities and communities, have become one of the fastest growing benefactors of this next-generation innovation.

Internet of things (IoT) technologies have proven instrumental in shaping the landscape of intelligent building architecture and automation, with power over ethernet (PoE) lighting emerging as a significant driver and support mechanism for smart network integration and success. As office workers across the globe face unprecedented changes in how businesses operate—including the resulting impact on physical working spaces, building managers, company owners, and employees alike—office occupants will need to rely on automated, data-driven building solutions in ways both old and new.

WHY PoE-CONNECTED LIGHTING IS A SMART CHOICE

PoE-connected lighting leverages Ethernet cabling to provide power and data transmission control capabilities that integrate into a building's smart system. This ability to migrate lighting controls to an IP-based infrastructure makes lighting a key IoT building asset, one that can be controlled synergistically along with other building functions. Digital integration means more meaningful data can be collected by a distributed sensor system as part of the lighting network infrastructure.

According to ledsmagazine.com, "Ethernet provides data and low-voltage DC power for everything from phone systems to cameras. PoE brings the potential for low-voltage devices to be installed away from AC power sources, such as in a ceiling. A PoE lighting system eliminates the AC-to-DC power conversion within each lighting fixture, improving overall building efficiency."¹

And according to securitymagazine.com, "Many smart building devices employ PoE to provide electrical power to the device using the same structured cabling that enables data connections, eliminating the need for separate AC outlets. Devices that are not yet PoE-enabled likely will be in the future. In 2018, IEEE ratified the 802.3bt standard, which allows up to 90 W of power to be transmitted over Ethernet cabling. These higher levels of PoE enable a new class of building devices—lighting, wireless access points, PTZ cameras and more—to be powered via the IP network."²

PoE FOR DIGITAL BUILDINGS

The main limiting factor affecting PoE use in new applications was the amount of available power. The 15.4 W at the power source is sufficient for most IP phones and 802.11a/b/g wireless access points (WAPs). Although some IP-based pan-tilt-zoom (PTZ) cameras are supported by 15.4 W, it may not satisfy the power requirements of today's advanced surveillance cameras, such as ultra-high-definition 360-degree cameras, outdoor thermal cameras with heaters, or PTZ cameras designed for low light, night vision, or thermal imaging functionality.

Today, there is demand for even higher power to support additional devices connected to the Ethernet network, such as connected lighting, motorized shades,

dispensers, thin client, 802.11ac WAPs and small cells, all of which can benefit from PoE.

The latest IEEE 802.3bt standard, published in January of 2019, increases the maximum PoE power available mainly by utilizing all four pairs of the structured cabling. Furthermore, IEEE 802.3bt extends the power classification information exchanged during initial negotiation to allow meaningful power management capability, enabling support of multiple PoE classes while also being backward compatible. These enhancements solve the challenge of higher power and more efficient PoE delivery systems.

The IEEE802.3bt standard also introduces Type 3 and Type 4 power sourcing equipment (PSE) and powered devices (PD), working over four pairs as shown in Figure 1. The standard also improves the mutual identification process between the PSE and the PD. Additional features include automatic class functionality, extended power capability if channel length is known, and low standby power support.

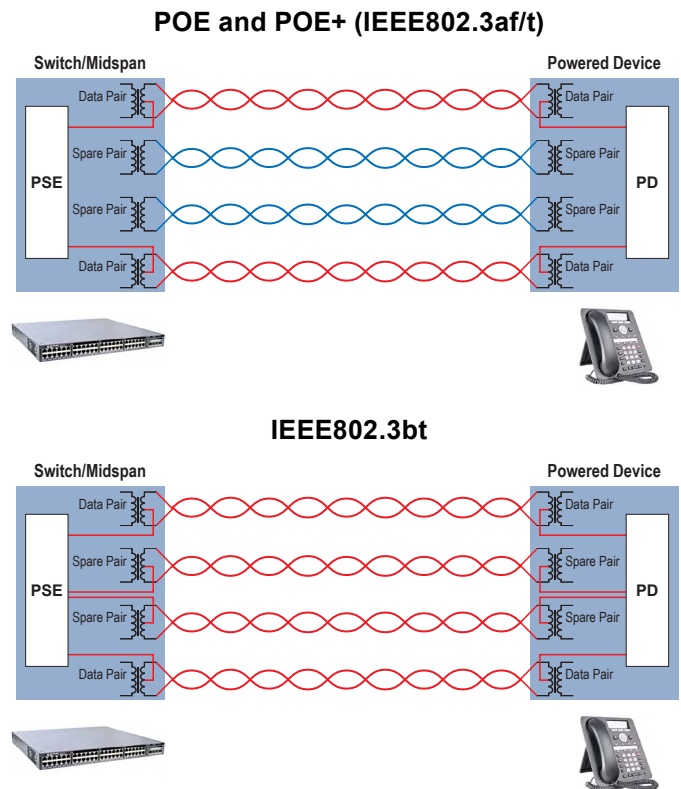


FIGURE 1: (Top) shows two balanced twisted-pair used for power and data, (bottom) shows four balanced twisted-pair for power and data.

Perpetual PoE is an enhancement feature that helps enable PDs (light fixtures) connected on certain ports to continue to receive power during a soft reload of the switch (PSE).

Other features implemented in IEEE802.3bt that are important for smart building and PoE lighting applications include:

Maintain Power Signature (MPS)

Deploying large numbers of PDs leads to considerable standby power. For example, in PoE LED lighting applications, it is critical to reduce the standby power due to the large number of ports in a typical application. Also, while the light is off, the port should stay on and consume as little power as possible.

Auto Class

Classification is the process where the PSE detects the PD's power requirements by using the physical layer. Type 3 and Type 4 PSEs may choose to implement an extension of the physical layer classification known as auto class. The purpose of auto class is to let the PSE determine the actual maximum power drawn by the connected PD. The PSEs implementing auto class will measure the power consumption of the connected PD throughout a defined period of time; during this time, the PD will consume the maximum power it will ever require. The PSEs can set the maximum power output based on the power drawn during auto class plus margin.

Extended Power

IEEE802.3bt defines the minimum power that the PSE should source and maximum power that the PD should expect to receive. There is some amount of power that is "saved" for dissipation on the cables in the worst-case scenario of 100-meter (≈ 328.084 ft) cables. The previous standard, IEEE802.3at, considered the worst case. Following that approach means that for a PSE sourcing 90 W output, the PD should expect that only 71 W and 19 W are "saved" for dissipation on the cables in case the PD is deployed 100 meters (≈ 328.084 ft) from the PSE.

However, is that always the case? What if the PSE and PD are in close proximity? If the cable losses are much lower, can less power be saved? The idea of the extended power feature is to allow the PD (or PSE) to use the maximum available power based on the cable's true total resistance. Once the PD measures cable resistance, it can calculate the power that will be lost on the cable and claim the worst-case reserve to be used by the PD. At worst, the power reserve will be the same as in the current standard, but it also can be much lower.

Backward Compatibility

Although new features were added, higher power is supported, and some algorithms were changed to ensure interoperability. The idea is that the system will work with legacy Type 1 and Type 2 devices. This should work automatically, as long as the PSE is capable in terms of power of supporting the PD and both are standard compliant. Should the PD require higher power (IEEE 802.3bt PD) and the PSE cannot support it (IEEE 802.3af PSE), the PD will either remain off or will turn on and consume only the power available from the PSE.

There are other important PoE features not defined in IEEE803.3bt but supported by PSE vendors that are particularly important for POE lighting and smart building applications. Fast and perpetual PoE, for instance, are enhancing the availability and uptime of port power after a power failure.

Perpetual PoE:

Perpetual PoE is an enhancement feature that helps enable PDs (light fixtures) connected on certain ports to continue to receive power during a soft reload of the switch (PSE). This feature enables devices to be powered during a software reboot. It is a critical feature for PoE connected lighting.

Fast PoE:

Fast PoE helps enable PDs (light fixtures) as shown in Figure 2 to illuminate with low brightness within 10 seconds (~15 W of power given via cable two-pair by switch hardware) after a hard reload (e.g., unplugging the UPS and re-plugging it or after a power outage). This is a critical feature for PoE-connected lighting to provide power at the device within seconds and not minutes of delay. Typically, switches can require up to 15 minutes to reboot.

While the current implementation options for PoE can power a broad range of devices connected to four-pair Ethernet networks, remote power delivery technology is still advancing. Recent standards development activity like 802.3cq and 802.3cv address some issues and technical discrepancies in current two-pair PoE applications (802.3af and 802.at) and four-pair PoE applications (802.3bt), adding clarifying text, new definitions, and other minor adjustments that improve accuracy and clarity.

In addition, ICT professionals should stay informed about single-pair Ethernet (SPE) applications (IEEE 802.3cg) designed to provide low-speed data connections for IoT/IIoT devices like sensors, actuators, and controllers used in industrial control and operations networks, including remote powering technology, referred to as power over data line (PoDL) and covered by the IEEE 802.3bu standard.

Like PoE, these remote power applications will ultimately make their way into smart buildings for powering low-speed sensors and controllers, such as those used in building automation systems. For those doing business internationally, refer to ISO/IEC JTC 1/SC 25/WG 3 that deals with customer premises cabling and generic cabling system standards in support of IEEE 802.3 Ethernet standards.



FIGURE 2: PoE pendants/light fixtures.

HOW CONNECTED INFRASTRUCTURES LEAD TO SMARTER OPERATIONS

Not only do IoT connected devices and platforms, such as PoE lighting, improve operational and energy efficiency, they create an interoperable mechanical and electrical ecosystem that ultimately results in a self-regulating, self-monitoring structure that provides intelligent data insights to help optimize performance around security, temperature regulation, lighting, space utilization, and more.

Therefore, it is not surprising that, according to Navigant Research, revenue from the advanced smart-energy sensor market is expected to almost triple between 2016 and 2025, from \$1.2 million to \$3.2 million.³ This is expected, considering the increasing demand for smart buildings. According to a January 2020 Research and Markets report, that market is expected to register a compound annual growth rate (CAGR) of more than 23 percent over the forecast period (2020-2025).⁴

What is even more eye opening is that this predicted growth likely does not take into account the office setting changes that will result as employees slowly transition from remote work back to populating physical buildings. The office landscape will be forever altered, and data-driving smart sensor technology will play a significant role in framing the office space evolution.

KEY AREAS THAT DYNAMICALLY ORCHESTRATE OFFICE BUILDING FUNCTIONS

Before highlighting the key areas within a building where smart functionality is an ideal fit, it is important to point out the core features inherent to any smart building.

According to trueoccupancy.com, every smart building has four things in common:

1. Core systems are connected and able to “talk” to one another.
2. Sensors are integral in the collection of data to inform resource allocation.
3. Information is gathered and analyzed in real time, constantly, to allow for course corrections and adjustments as needed.
4. The buildings generate a large amount of data.

After knowing these common smart building features, what are the key areas where smart technology is most likely to be applied to dynamically orchestrate building function and positively impact building capabilities and operations? Fedtechmagazine.com outlines four key systems that get automated:⁵

- **Heating, Ventilation, and Air-Conditioning (HVAC):** Smart controls help limit energy consumption in unoccupied or low-usage building zones, help determine faults, and reduce unnecessary HVAC usage.
- **Smart Lighting:** Leverages daylighting as well as advanced occupancy and dimming functions to counteract under-lit and over-lit spaces.
- **Automated System Optimization (ASO):** Uses advanced technology to collect and analyze building systems’ operational and energy performance data. ASO also makes changes based on external factors, such as occupancy patterns, weather forecasts, and utility rates.
- **Distributed Energy Resources (DER):** Energy generation and storage systems placed at or near the point of use, independent of the power grid.

Today’s in-building systems have the ability to collect more data leads and talk to more unrelated, yet interconnected systems, than ever before. This means sensors created for one specific function can be utilized to drive other building systems.

ELEVATING CONNECTIVITY MAKES A CONNECTED BUILDING “SMART”

The aforementioned features form the connective backbone of a smart connected building. However, it is the large amount of data generated by the sensors embedded within every connected system that supports smart automation, if used properly.

Today’s in-building systems have the ability to collect more data leads and talk to more unrelated, yet interconnected systems, than ever before. This means sensors created for one specific function can be utilized to drive other building systems. For example, a PoE lighting sensor, used to determine if a room is occupied and whether lights should therefore be turned on, can likewise provide information through integration with other functions to trigger whether audiovisual components should be turned on. The sensor can also be used as a trigger for room scheduling availabilities. It is this granular information exchanged between systems at a specific zone level that enables better use of a particular space.

This capability also extends to better overall use of the building as a whole. For instance, a sensor hosted inside a lighting fixture or luminaire can be tied to the HVAC system that controls temperature and humidity. This cost-effective symbiosis means that even when the lighting system is not using the sensor, it can still pass data on to the HVAC system to perform a specific action based on occupancy parameters, whether within a particular room or office zone.



FIGURE 3: Functional workspace environment.

Furthermore, this granular sensory network provides data and reacts in real time, making possible the collection of information over longer periods of time. This can, in turn, contribute to data-based analysis, trend reporting, and informed decision-making. This includes the creation performance highlighting trends around when a space is used most and which building areas are consistently under or overutilized. Are certain rooms or areas always occupied? Are there spaces that are rarely used? Are there too many or too few conference rooms? These kinds of insights and data can be used to change the scope of future space utilization and for collaboration planning. This will take on particular significance as companies rethink how an office functions in a post-pandemic world (Figure 3).

FACTORING IN THE PEOPLE: MARRYING BUILDING FUNCTIONS AND BUSINESS FUNCTIONS

Buildings benefit from a connected smart sensor platform within the scope of facility function, improving security as well as energy and space utilization. In order to realize

the greatest IoT integration and benefits, however, data from connected buildings must be merged with business data, such as that from accounting, human resources, and enterprise resource planning (ERP) systems. Accomplishing this ties together the building with the business, which creates one harmonized entity. It is at this point that data can be analyzed to discern whether the building and workspace have an impact on business performance and work well-being. For example, data can spotlight whether work habits are different in one building space than another or if one area experiences more turnover.

Everyday life has become more connected in both the personal and professional arena. The IoT networks are continuing to grow, creating new opportunities to positively impact people, as well as for people to better impact their surroundings. Today's connected systems can react to occupant behavior in real time while assessing occupant needs and adjusting accordingly. That is why sensor-connected devices can provide information around its basic function and status along with any stress (e.g., running at a high rate or temperature) that the infrastructure may be experiencing.

In the near future, such advancements in smart buildings will result in the ability to achieve predictive maintenance, where a historical map exists for all connected devices. This, in turn, will lead to self-monitoring that accounts for both the building facilities and the people within them.

USING PoE LIGHTING AS THE FOUNDATION OF A SMART CONNECTED BUILDING

PoE lighting applications are accelerating and driving adoption of IoT within office buildings due to the ability to power and control connected sensors and systems beyond the scope of lighting. Ethernet is the backbone that makes this possible, creating an environment where the building can be sensitive to the occupant, leading to increased comfort and productivity.

Because PoE lighting enables an ethernet-based infrastructure, combined with a massive sensory network, it can serve applications focusing on space optimization, security, and safety enhancement within a smart building or smart office environment (Figure 4).

While some examples already have been touched upon, here is a more in-depth overview of ways that PoE lighting already serves as the foundations of today's smart buildings:

Controlling Natural Light

PoE lighting offers seamless integration and coordination of automatized shading for full management of natural and artificial lighting. Controlling lighting and shades together via a smart network increases comfort and productivity in an office, boardrooms, and other working spaces while conserving energy based on data derived from occupancy sensors within the lighting system. For example, blinds or shades can be programmed to automatically close during the afternoon in spaces that face south, or if no one is present in an area, that data can be shared with the HVAC system to raise or lower temperature accordingly. Sensors also can be programmed to automatically adjust blinds based on the changing angle of the sun and its position in the sky throughout the seasons.

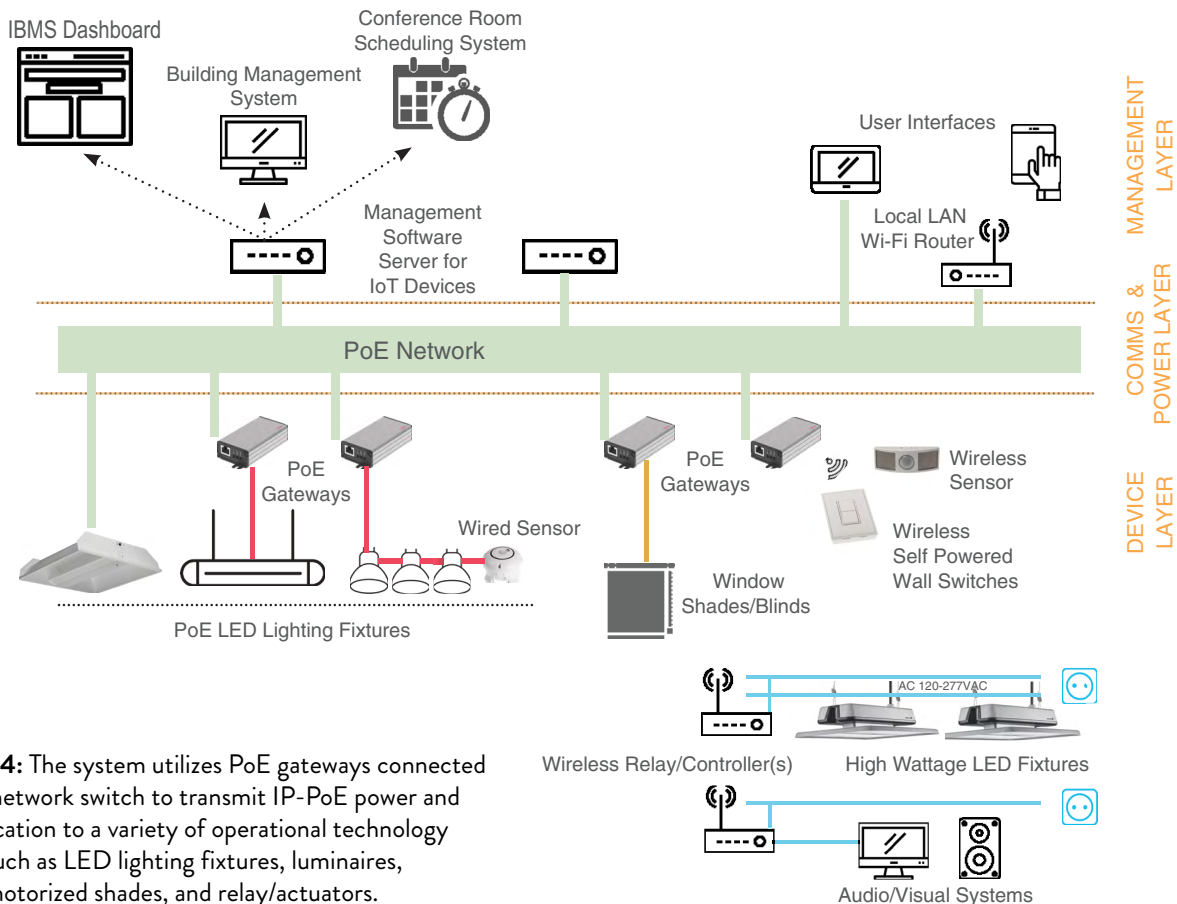


FIGURE 4: The system utilizes PoE gateways connected to a PoE network switch to transmit IP-PoE power and communication to a variety of operational technology devices, such as LED lighting fixtures, luminaires, sensors, motorized shades, and relay/actuators.



FIGURE 5: PoE gateway and temperature sensor.

Temperature and Humidity Control

The ability to deploy a granular array of self-powered, wireless temperature and humidity sensors leveraging the connectivity already in place is accomplished via connected lighting PoE nodes. This allows for more accurate temperature and humidity sensing capability in each space at a fraction of the cost of a traditional standalone HVAC solution. Sensors measure temperature and humidity and then pass the collected data to the building automation system or HVAC controls.

Safety and Security

Network-connected lighting can be integrated with a building's fire alarm and other safety systems. In the event of a fire or other emergency that triggers a system alarm, building lights and multi-colored indicators can simultaneously react to illuminate pathways for occupants to follow while alerting them to an emergency situation, such as a fire, tornado, security breach, and other dangerous events. Network-connected lighting also can be integrated into a building's digital signage and voice alarm platform, AV systems, and security system. When triggered by a security event, the lighting system can react accordingly, providing a pathway while the paging system informs building occupants with important information. Window shades also can be set to automatically default to a predefined state, as in a lockdown scenario.

Booking and Scheduling

Smart reservations let employees reserve meeting rooms. If people are no-shows based on occupancy data from lighting sensors, the room can be "released" so other users can reserve the space. In addition, as soon as a space

or room in use becomes available, an indicator LED can change status/color, so others will know that the space is open. In an education application, this capability can help students and teachers during tests. For example, a teacher can start a test and set the lights at high brightness to enhance alertness. When the test-taking time is almost over, the lights can notify students that it is time to wrap up.

People Counting and Space Activities

As part of a sensory network, a PoE lighting system can act as host for advanced sensors that enable people counting, thereby gaining a better understanding of how and when space is utilized. This permits space management to be optimized, along with supporting building safety, by ensuring more people are not occupying a space than legally allowed.

SMART BUILDINGS 3.0: LIKELY NEW ROLES FOR SMART SENSORS AND CONNECTED INFRASTRUCTURES

Seemingly for every aspect of our work and personal lives, the role and configuration of buildings and offices will change as a result of the pandemic. With the current shift in workspace environments, the ability to configure and reconfigure spaces digitally without making any physical changes will soon be in demand, as will further smart technology innovations.

PoE lighting is ideally suited to support new smart, connected deployments that will likely be on the horizon. For example, while ceiling lighting is ubiquitous and convenient to deploy, the need for sensors that can record specific interactions closer to ground level has been on the rise—especially pertaining to smart office furniture. In fact, according to recent research, the smart office furniture market is expected to grow by \$266.6 million during 2020-2024.⁶

PoE lighting sensors can be used to create a connected furniture/desk sensory network to ascertain whether specific desks are occupied. This will be important as businesses slowly migrate workers back to the office, most likely at half capacity or in shifts. Desks will be spaced farther apart and, possibly, not assigned to just one person anymore.

Smart office furniture can be tied to smart desk apps that show which desks are available, and it will likely let a user “book” the desk for a certain time slot. In addition, when a desk becomes free, an alert can be sent to the cleaning team that it is ready for cleaning and disinfection. Once cleaned, the desk can be marked “available” on the app.

PoE lighting infrastructure, as part of an intelligent building network, could also help support social distancing with lighting prompts. In addition, there is aid for spatial reconfiguration by supplying data around which office areas were already overcrowded and which innately had lower occupancies. This, in turn, can help companies determine how to restructure existing physical spaces.

Another approaching use case could be the integration of antibacterial or antiviral lights for automatic sterilization purposes. This could be accomplished by smart furniture or overhead lighting, which could be programmed to run overnight or after occupants leave a room or a desk. How quickly this use case comes to fruition is uncertain—likely sooner than later. What is certain is the intelligence provided by a digitally-based PoE platform will afford the flexibility to allow for easy spatial reconfiguration and adjustment based on both occupant behavior and evolving workspace requirements.

CONCLUSION

Global revenues for smart commercial-building IoT is expected to increase to \$84 billion by 2022, a 19.4 percent CAGR.⁷ IoT technologies will continue to deliver smarter, more automated and better-connected systems in new and existing buildings, especially as the demand for convenience and greater attention to the space and layout continue to rise. PoE-connected lighting is a key component of an IoT-driven smart building, bringing with it the ability to converge different functions within a single infrastructure to form the foundation of a highly integrated structure. As people continue adapting to the “new normal” in the physical workplace, PoE-connected lighting will grow as a foundation for IoT innovation that supports intelligent disinfection of work surfaces and office spaces, enabling a safer environment, potentially without the need for human intervention.

AUTHOR BIOGRAPHY: Giovanni Frezza is the director of products in Molex’s Connected Enterprise Solution Business Unit. He leads the product management and engineering organizations for network-connected solutions. His vision and contributions in recent years have influenced and impacted the company’s digital building partner eco-system initiative and entire PoE connected lighting segment.

Giovanni received an M.S. in physics from the University “La Sapienza” of Rome (Italy) in 1998. Currently, he is involved in Ethernet-based solutions, IoT applications, building technologies, Industrial automation, cloud-based platforms, and smart grid applications, while promoting with other industry leaders open standards and interoperable architectures for innovative systems integration. Giovanni is the author of several publications and patents for smart building and building connected solutions. He can be reached at giovanni.frezza@molex.com.

REFERENCES:

1. Maxwell, Krystal. “PoE is Poised to Accelerate Intelligent Building Growth,” *LEDs Magazine*, 25 February 2020.
2. “Preparing for the Smart Buildings of Today: A History of Change and Technology Leadership,” *Security Magazine.com, BNP Media*, 23 March 2020.
3. “Smart Buildings and The IoT,” *FacilityExecutive.com*, 17 September 2019.
4. “Smart Building Market: Growth, Trends & Forecasts to 2025,” Research and Markets, *GlobeNewswire*, 21 January 2020.
5. Stone, Adam. “The Tech Behind Smart Building Automation Systems,” *FedTech*, 23 January 2020.
6. “Pre & Post COVID-19 Market Estimates-Smart Office Furniture Market 2020-2024 Developments in Connectivity Technologies to Boost Market Growth,” Technavio Research, *Business Wire*, 24 April 2020.
7. Donati, Angelica K. “What Areas Should You Be Excited About in Smart Building Tech?” *Forbes Magazine*, 21 February 2020.



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