Game changing technology creating exciting future for PoE solutions

AMAZING PROSPECTS FOR PoE

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CONTENT

Power-over-Ethernet (PoE) infrastructures are well on their way to becoming a dominant technology. They combine data communication and power supply via a single Ethernet cable. The range of applications for PoE is wide. In the next five to ten years, PoE will continue to establish itself strongly thanks to new trends, PoE lighting and DC-grid technology are the most relevant to consider.

Our living and working space is currently changing at a rapid pace, including the living and working environment. The desire for greater well-being, security, energy efficiency and comfort are increasingly coming into focus when it comes to installing building technology. One way to ensure smooth operation is to use smart solutions. With PoE and IoT (Internet of Things) to network building systems, businesses and residential buildings are more energy-efficient, sustainable, cost-effective, secure and easier to control. In this regard, office, hospitality, healthcare and education are emerging as the four most promising market segments for immediate PoE innovation. Each of these industries faces rapidly changing market realities, especially as the pandemic continues.

1. INTELLIGENT BUILDING MANAGEMENT APPLICATIONS SUPPORTED BY PoE

PoE has enormous potential. The technology is capable of supporting all kinds of processes and being the backbone of complete building services. The range of applications is broad, for example predictive heating-ventilation-air conditioning, personalised lighting control, indoor way-finding, asset tracking to identify hardware and support areas, centrally managed security, dynamic personalised signage, real-time conference room availability and flexible workspace allocation. High reliability, ease of use and maintenance fulfil PoE by centralising the infrastructure.

2. PoE: MAIN DRIVERS AND POSSIBILITIES

Various factors are currently favouring the spread of PoE solutions. With regard to ecology and climate protection, there is a growing awareness of saving energy and reducing CO_2 emissions. Another factor is the operating costs. Due to increasing cost pressure, companies are faced with the challenge of reducing the power consumption of communication and data networks. Technological progress enables higher performance rates over 4-wire pairs. This is associated with increasing investments in Ethernet infrastructures. According to BSRIA's Grandview Research, PoE port shipments will increase sharply in the coming years. In 2023, the number of ports sold will be between 180 and 230 million. In 2022, the market is expected to need around 10 million PoE switches.
As shown in **Figure 1,** VoIP technology took the top position among PoE applications in 2019 with 36 million (= 32 % market share) installed ports. This is followed by the segments wireless access points (23 %), CCTV cameras (18 %), sensors (7 %) and motors and drives (4 %). The "Other" segment comprised 16 %. This includes BACS, A/V, Access Control and Lighting. The market for PoE lighting systems is still in its infancy, but it is booming. Here, an annual doubling is to be expected.

Figure 1

PoE lighting systems market is still in the early stages, but it is booming and it will DOUBLE in size yearly

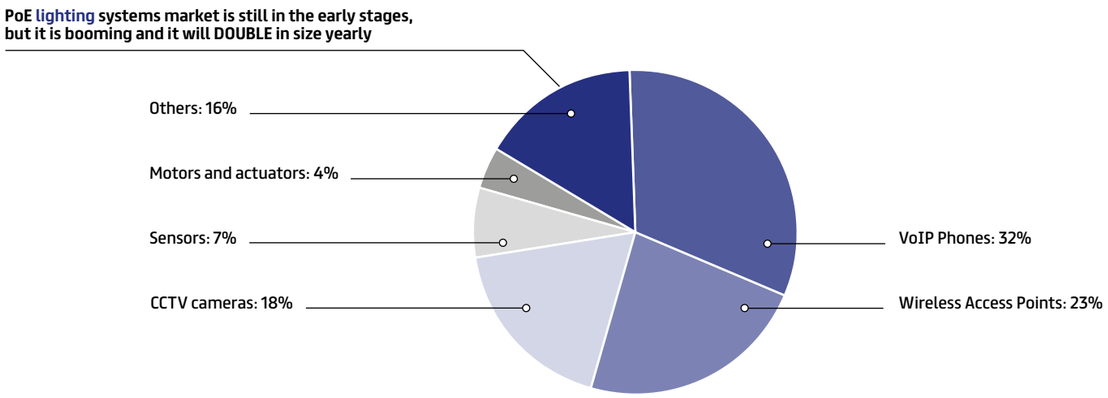
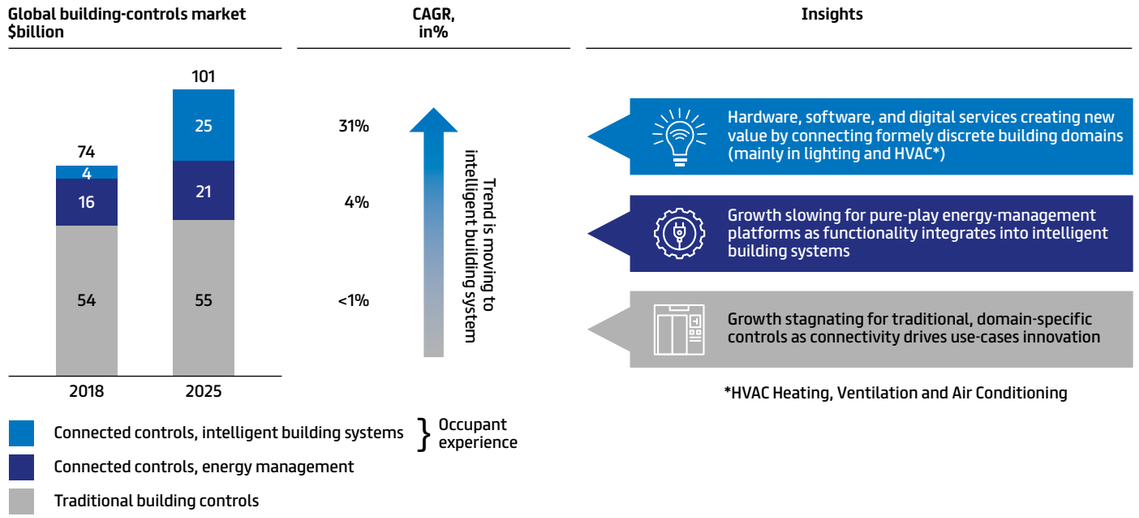


Figure 2



Source: McKinsey – Laying the foundation for success in the connected building era (2018)

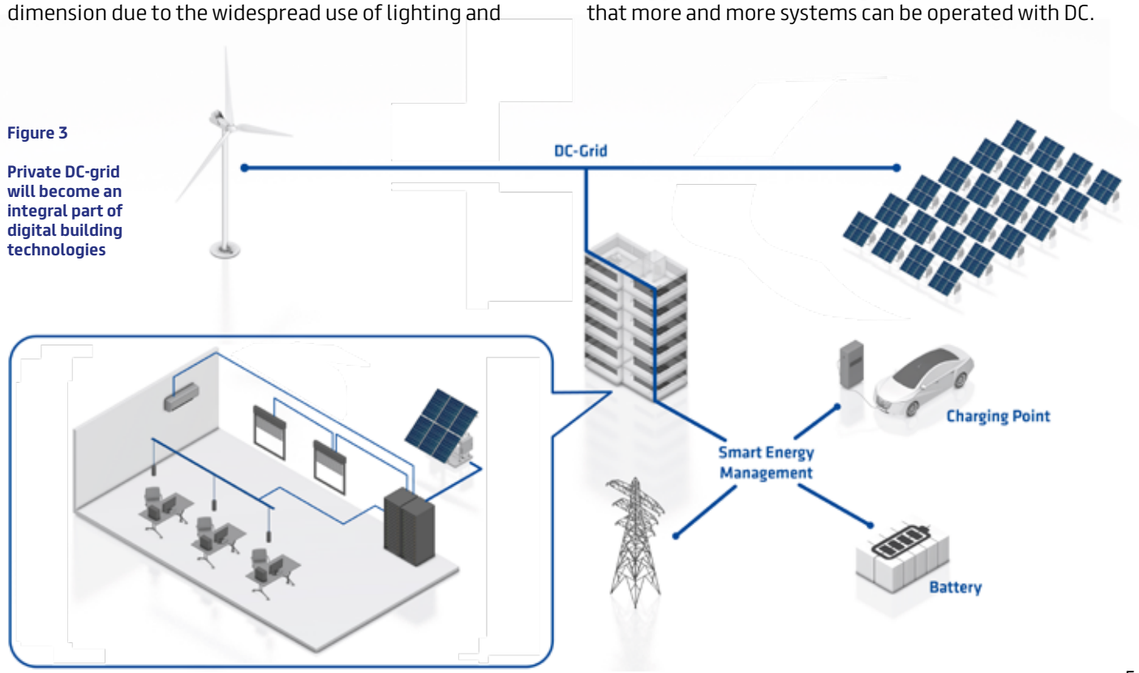
This development is also confirmed by McKinsey. As can be seen in **Figure 2,** the consulting firm forecasts the greatest growth potential for the "intelligent networking of hardware, software and digital services of previously separate building areas". In this segment, lighting is the biggest driver. The influence of lighting is greater than with other technologies. As a feel-good factor, it plays a significant role in the living and working environment. In addition, the installation takes on a considerable dimension due to the widespread use of lighting and therefore has a weighty role. Another positive aspect: PoE-supported lighting can already be implemented at a good price today.

3. DC GRIDS VIA PoE

Another trend that will favour the spread of PoE in the coming years is the increasing use of DC grids and the fact that more and more systems can be operated with DC.

Figure 3

Private DC-grid will become an integral part of digital building technologies



DC grids as illustrated in **Figure 3** are central DC network infrastructures in industrial or production facilities. Here, all components are supplied within a self-contained, self-sustaining system via a DC voltage source, and not via the common AC grid as was previously the case. There are various reasons for adopting DC grids, first and foremost energy efficiency, cost reduction and energy flexibility in production.

By implementing to a DC grid, energy generated on site, both from renewable sources and recuperative processes, can be stored more efficiently. In times of massive energy policy rethinking and technological progress in energy storage and power electronics development, sticking to conventional AC/DC power supply is no longer the preferred choice. This is because, in addition to a significant reduction in costs and a saving in energy demand, a power supply via DC Grid is more robust with regard to fluctuating grid quality. It is also able to react flexibly to changing energy supplies, especially when buffering peak loads and bridging grid failures.

PoE proves to be a suitable technology for DC grids to supply power to all participating powered devices. The maximum power that can be transmitted via PoE integrates well for the operation of DC grid infrastructures. Thus, the increase and growing acceptance of DC Grids is an important driver for the installation of PoE infrastructures.

4. PoE AS SUBSTITUTE FOR OPERATIONAL TECHNOLOGY (OT)

In building management, devices and machines are typically subject to consistent monitoring. On the one hand, to detect faults at an early stage and to keep the extent of the costs for the necessary repairs as low as possible. On the other hand, downtimes in the operating process can often be avoided through monitoring. Operational technology (OT) plays an important monitoring role in this context. OT comprises hardware and software that is used to control and monitor devices and systems all over the managed building, including their processes.

Unlike IT-based monitoring models, OT uses proprietary technologies, interfaces and protocols. The operating technology virtually controls itself in a closed system according to its own protocol. If, on the other hand, equipment or machine control is carried out with the help of IT, error messages are sent to a central location. These are then rectified directly via control mechanisms or forwarded to another instance to solve the problem.

In the past, OT systems were isolated from the IT system usedin companies. However, digitalisation, industrial networking and the Internet of Things are increasingly causing a convergence of classic IT and OT. IT/OT convergence offers many advantages but is also associated with challenges and risks. Convergence is the basis for Industry 4.0 and enables solutions such as predictive maintenance and predictive monitoring. OT in critical infrastructures requires special protection. Typical requirements for OT are high reliability, security and availability. In addition, real-time capable processes must be possible. In order to integrate all systems, even those without a direct or difficult power connection, into the monitoring, PoE lends itself as a network infrastructure. This is also where a lot of potential for PoE lies.

Table 1: PoE standards and the different levels of power they allow for

Standard	Type	Class	VPSE (min) supply voltage	Max. current per pair	PPSE max. power of the supplier	PPD max. power to the unit	Pairs
802.3af	Type 1	Class 1	44V	350mA	4W	3.84W	2
		Class 2	44V	350mA	7W	6.5W	2
802.3at	Type 2	Class 3	50V	600mA	15.4W	12.95W	2
		Class 4	50V	600mA	30W	25.5W	2
802.3bt	Type 3	Class 5	50V	500mA	45W	40W	4
		Class 6	50V	500mA	60W	51W	4
	Type 4	Class 7	52V	720mA	75W	62W	4
		Class 8	52V	860mA	90W	72W	4

5. PoE COMPONENTS AND STANDARDS

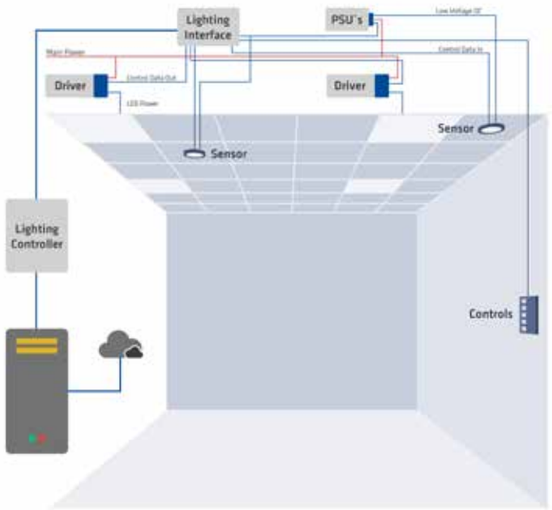
The backbone of PoE-based smart solutions is the cabling infrastructure with fail-safe, high-performance copper cables and connectors. This networks sensor devices and lighting elements with the PoE switches and gateways as well as LED drivers. In contrast to the classic installation with different types of cable, with PoE only one type of cable is sufficient, which is compatible with all PoE-based devices. Most of the electronics are in the central rack. Only small parts of the LED driver are installed in the ceiling, which, by the way, is where about 70 percent of PoE installations are located. **(Figure 4)**

With PoE topology, users have the choice between mid-span and end-span networks. The dominant end-span architecture uses a network switch that supports PoE. Mid-span, on the other hand, uses an external PoE injector installed between a non-PoE switch and a powered device (PD). Both types of architecture make the transition from the old network environment to a PoE network much easier.

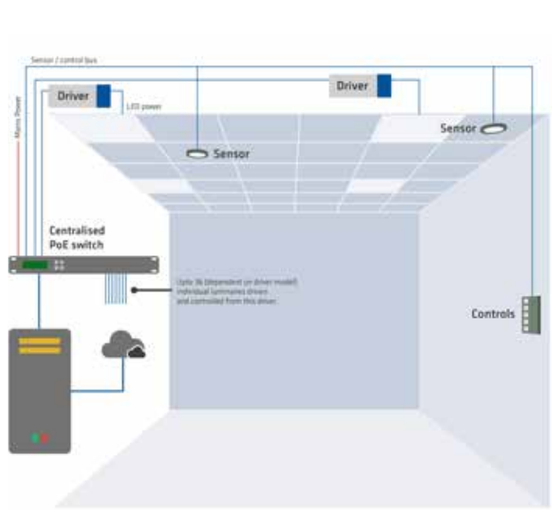
PoE is defined in several standards which allow for different levels of power depending on the standard. **Table 1** provides an overview. After the IEEE 802.3af standard in 2003 and IEEE 802.3at in 2009, the IEEE adopted the IEEE 802.3bt standard in the third quarter of 2018.

Figure 4

Classical Dali/KNX
Typical commercial installation



PoE base centralised implementation of LED



6. GENERAL BENEFITS OF PoE INFRASTRUCTURES

The number of devices and services integrated into the network continues to increase. This is driven by the demand to standardise the cabling infrastructure. This is accompanied by the demand for standardization of the cabling infrastructure. The demand for intelligently networked buildings based on PoE has increased continuously over the last few years - both in the area of commercial and industrial end users.

Ease of installation & maintenance

PoE-compatible devices can be connected to the network without much effort and are self-configuring. Since only low voltage is used, no electricians are required for both implementation and maintenance. The installation of the network is highly standardized and verifiable according to the applicable installation standards.

PoE reduces costs

Users benefit from dual use through the Deployment of network cables for power supply, which can eliminate power cables, resulting in lower installation costs. In terms of operating costs, centralized management and standardized control of building applications with the associated automation options allows efficient optimization approaches. In addition, the space requirements of PoE components are often significantly reduced compared to alternatives with conventional power supply. External power supplies often become redundant. In addition, system availability is improved. In the event of a power failure, uninterrupted operation of the connected devices can be guaranteed via PoE by using a UPS to back up the PoE switch. This is not only an invaluable advantage for a WLAN infrastructure

Sustainability / Climate protection

PoE via structured cabling systems with centralized management makes a valuable contribution to improving the energy efficiency of buildings, thereby reducing CO_2 emissions.

Wellbeing

Another aspect is increasingly coming into focus: environmental conditions such as temperature, lighting conditions and air quality influence performance, work quality and ultimately the health of people in smart buildings. PoE can be used to set up and operate a sensor network that ensures optimal working conditions, for example, by regulating lighting, ventilation and air-conditioning technology. This improves both employee satisfaction and work performance.

7. DIGITAL BUILDING SOLUTIONS ON THE RISE

The progressive development of PoE technology enables the power supply of a growing number of applications and services in buildings via data cables. Intelligent solutions based on PoE technology are becoming increasingly widespread. The most relevant applications in the context of “Smart Building” are PoE Lighting, PoE Emergency Lighting and IoT sensor networks.

PoE Lighting

For buildings of all sizes, PoE Lighting can be used as a flexible and at the same time sustainable lighting solution. Compared to conventional lighting systems, the smart concept scores with lower effort for installation, maintenance and operation as well as reduced energy consumption and CO_2 emissions. The interaction of sensors, LED luminaires and intelligent control offers users attractive options for optimising operation.
Since PoE Lighting is IP-based, the lighting gets intelligence. By connecting the control to the data network, the lighting can be easily automated. The light comes on automatically when it is needed and goes off again when there is no one in the room. This function ensures that lights are not left on overnight. Control via the data network further enables “Daylight Harvesting”. The LED lighting is able to supplement the daylight in the room to the desired illuminance at any time. The setpoint can be specified individually for each area and for each workstation.

PoE versus DALI/KNX

LED luminaires require significantly less power than conventional luminaires. However, LED luminaires only show their full potential in combination with appropriate sensors and an intelligent control system that quickly and automatically adjusts the illuminance to the respective requirements. In this way, a reduction in power consumption of over 70 percent is possible compared to conventional lighting. Conventional DALI/KNX lighting systems for this purpose are complex, limited in application options and associated with significantly higher costs for initial installation and operation. In addition, licensed electricians are required for installation. Ultimately, the installation of a DALI/KNX lighting solution requires more components and systems than PoE Lighting.

Components of a PoE Lighting system

The components of an intelligent PoE lighting solution include a central power supply system, PoE switches and PoE drivers as well as the LED luminaires, the actual light sources. Various products are available here, some with very different quality characteristics. As far as the power supply system is concerned, users should pay particular attention to the quality of the following features when purchasing:

- High performance
- Certain number of power supplies to achieve the required overall performance
- High efficiency
- Universal mains input
- Power supply technology for IT and TC
- Business critical light redundancy
- Exchangeability of power supply units during operation
- Short circuit and overload protection

PoE uses Cat.6A cabling, via which up to 72 W can be supplied to the consumer in conformity with the standard with a SELV <60VDC(Safety Extra Low Voltage). A 230V AC voltage is not necessary. A Cat.6A cabling can be equipped with a warranty period of over 25 years, which also supports the PoE lighting application.
The LED luminaires in a PoE lighting system should provide flicker-free, color-tunable light for creating different lighting environments.
PoE enables future-proof lighting solutions such as the data transmission technology VLC (Visible Light Communications), which transmits data or information using the medium of light. Lighting VLC technology is the basis for Li-Fi applications and indoor positioning systems (IPS), the development of which is currently progressing strongly. Upcoming system solutions can be easily integrated.

By integrating with Building Management Systems (BMS), the lighting system can be operated and monitored cloud-based, which increases operational efficiency. PoE devices should support the open network protocol M QTT (Message Queuing Telemetry Transport) for this purpose. MQTT is a message protocol for low-bandwidth, high-latency networks. Therefore, it is ideally suited f or machine-to-machine (M2M) communication. In the IoT, MQTT is used up to the connection of cloud environments.

PoE switch

Various types of PoE network switches are currently available on the market. With the PoE switches, the network connection and the power supply of the PD (Powered Device) can be efficiently realized via the Ethernet cable. A PoE switch only requires a power cable for the switch and a network cable for connecting PDs. Then the PD can be plugged directly into the PoE Gigabit switch port for both data transmission and power supply. PoE switches with 8, 12, 24 or 48 ports are widely used. State-of-the-art for a PoE port is:

- Support for IEEE802.3af, IEEE802.3at or IEEE802.3bt, 10/100/1000M adaptive and PoE features, 90 watts output power, port auto flip (Auto MDI/MDIX), link monitoring, irregular self-test and recovery

- Flow Control, IEEE802.3x for full duplex mode and backpressure function for half duplex mode, lightning protection, Surge/General Mode 6KV and Differential Mode 4 KV, ESD: 8KV

- Support for a 1 U rack installation

PoE switches offer advantages in terms of the following aspects:

1. Flexibility: PoE switches in wide-area deployment eliminate the need for non-PoE switches, additional PSEs and extension cables and create great flexibility for additional PoE devices such as IP surveillance cameras or WLAN access points.

2. Simplicity: Without additional PSEs and installation points, the PoE switch simplifies the overall network installation. In addition, good PoE switches also enable Simple Network Management Protocol (SNMP), which provides an easier way to monitor and manage the switch.

3. Cost-effective: The PoE network switch eliminates the need for users to purchase and install additional power cords and outlets, resulting in significant savings in cost and time for installation and maintenance.

PoE Driver

PoE drivers are the third component required for PoE lighting solutions. They combine high-power LED lighting applications with PoE connectivity. As a PD device, they draw power from the PSE. Ideally, they have multiple independent outputs and draw power and control data from a single PoE network connection. As such, they offer exceptional flexibility and ease of installation. They are to be optimized to achieve smooth dimming and flicker-free lighting performance.

Requirements:
- Compact design for ceiling mounting
- Support of the lighting control protocols RDM, Art-Net 3, sACN and MQTT
- Monitoring and protection against short circuits and interruptions
- LED current and voltage monitoring in real time
- Linear and curved output options for each channel

PoE Emergency Lighting

We encounter mains-independent emergency lighting every day in ceilings, on walls or above doors in all kinds of places in public buildings, factories or company complexes. In emergency situations, when the power fails, it provides sufficient orientation for building evacuation. Escape routes are thus reliably marked. If the regular, mains-dependent lighting switches off, it can otherwise become dark very quickly and panic can break out.

In order to be independent of the mains in the event of an emergency, emergency lighting is provided by means of a rechargeable battery or a power generator. From the time of the power failure, it must be possible to supply the emergency lighting independently of the mains for at least three hours. It is also important that the lighting is switched on immediately, i.e. a duty cycle <1s.

The basis for the installation of emergency lighting is EN 1838 for applied lighting technology as well as around 30 other standards, regulations and directives, including for example ISO 30061:2007, CIS S 020/E:2007 or EN 50172 for emergency lighting systems. In addition to professional installation, these also stipulate regular maintenance.

Emergency lighting must allow sufficient visual conditions so that people can leave the buildings quickly and safely. Emergency lighting today mostly works with LED and rechargeable battery. With LED emergency lighting, energy efficiency is a major advantage: the luminaire shines longer because the battery is used efficiently. In addition, LED requires less maintenance.

Benefits of PoE Emergency Lighting

In this area of application, too, an emergency lighting system via PoE offers many advantages over a conventional mains voltage supply. As with all other PoE applications, no electrician is required for installation. Emergency lighting components such as signs with illuminated walkers or spotlights for corridors and open areas are easy to implement via plug-and-play. In addition, synergies result from the use of already installed Ethernet data cables. The use of Cat.6A cables, for example, enables installation costs to be reduced by 80 percent. The officially required three-hour runtime is easily achieved with 3Ah LiFePO4 batteries. The support of software for self-display and self-testing enables remote monitoring and simplified maintenance.

Components of a PoE Emergency Lighting system

A PoE emergency solution consists of a PoE POD device and PoE emergency signs. The POD communicates with the luminaires and the central control point via Cat.6A patch cables. In addition, the POD device should have a full self-test function that automatically reports and detects faults.

Various options exist for PoE emergency signs for ceiling or wall mounting. They should meet the following characteristics:

- Integrated electronics and battery
- LED charge/current indicator
- Three hours operating time
- Power supply: LED power with nominal 1.3 W.
- Input connector RJ45 compatible.
- 3000mAh 3.2V LiFePO4 battery.
- Operating ambient temperature: 0 to 50 °C
- Protection class: IP40

For the most efficient use, users have several visual options when choosing emergency luminaires for corridors and open areas. To meet aesthetic requirements, the size of the luminaires should be small. The following features prove ideal:

- Integrated Halo LED display
- Single RJ45 input connection to battery
- Power supply: LED voltage: nominal 3.4V DC; LED current 450mA; LED connector 1 x C4202-H02X2.
- Luminous power: Output luminous flux at 450mA, 3 hours: 180lm (nominal), CCT: 6000K, CRI: 70
- Lens Options: Corridor: 155° x 115°, large range 13

IoT sensor networks via PoE

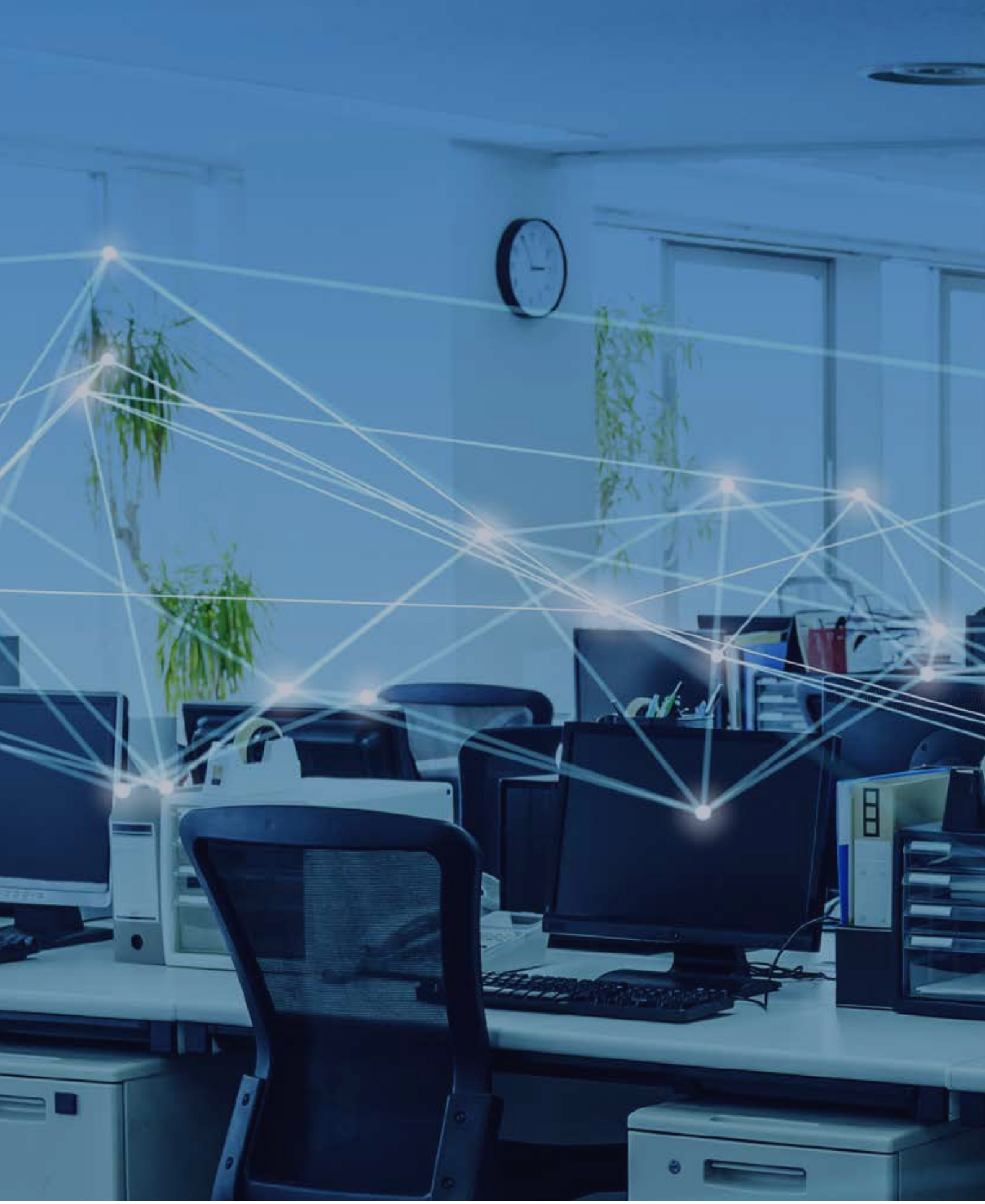
Once a comprehensive PoE network has been set up, a wide range of possibilities and functions are created by networking sensors such as Wall Switch, Kinetic Thermostat, Smoke Alarm, Heating Control, Relay/Blind Control, Occupancy, Themostat, HVAC Control, Dimming Wall Switch and Amient Light. Control is via simple gateway systems that communicate with the sensors using EnOcean, Bluetooth 5.1, Zigbee 3.0 or Thread wireless standards. Connection to the cloud and integration in BMS solutions is possible via the MQTT message protocol.

Of particular interest is the PoE connection of well-being sensors with a 360-degree detection range via standard PoE RJ45 connections via Bluetooth and Beacon. They enable extended daylight use, integration into building systems for climate control and measurement of ambient noise. Sophisticated digital gas sensors measure indoor air quality, for example, CO_2 levels. As additional functions, the sensors can detect changes in colour, brightness and temperature. Integrated PIR sensors detect heat emitted by a body or a hot engine in the form of IR radiation.

An IoT sensor network creates the conditions for implementing a wide range of monitoring, control and optimization concepts.

8. CONCLUSION AND OUTLOOK

With an installed base of currently around 1 billion ports, Ethernet is the undisputed number one network protocol. This ensures users the long-term, cost-effective availability of components and devices for this standard. The application areas presented in this white paper offer users practical optimization approaches with short amortization cycles. Low-hanging-fruit PoE lighting helps the cautious to take their first steps and gain their own experience. Because it is the better solution with lower investments. Those who are already convinced are building their Smart Building of the future with a comprehensive PoE infrastructure, in order to be among the early bird users of innovative concepts in building management.



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