Maximizing potential of Smart Buildings:

Unleashing power of IoT-PoE networks with strategic and efficient Universal Connectivity Grid

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Smart cities consist of smart buildings. The Internet of Things (IoT) and connectivity components of smart cities – network infrastructure that connect assets and collect, manage and analyze data from them – are extensions from today's smart industrial plants, office complexes, schools, hospitals, shopping malls, sports venues, etc.

Emerging smart building applications are enhancing productivity and enabling innovation-focused workplaces. As these applications evolve, the connectivity linking a building's IT and operational technology (OT) systems make it possible for business occupants to maintain a conducive work environment. The connected systems now regulate security, environmental conditions, lighting, communications and other factors; they have become critical to the efficiency, effectiveness and economy of an enterprise's operations.

Smart buildings herald the next level of improvement in efficiency and productivity in operating a building intelligently through technology. Singapore's ambition to become a Smart City, for example, has led to smart building controls and strategies being introduced in the country's Building and Construction Authority (BCA) Green Mark for Existing Non-residential Buildings (GM ENRB: 2017) covering energy monitoring, demand control as well as integration and analytics. The BCA has also pushed for more energy-efficient solutions for buildings with its Super Low Energy Programme.

These initiatives encourage the use of automation and data analytics that enable building operators and professionals to enhance productivity and maintain energy efficiency by optimizing equipment and related processes. These efforts to reduce energy and improve the indoor environmental quality for occupants utilize sensors, data acquisition devices, signal conditioners, and wired and wireless connectivity.

Sensors could allow seamless transitions in lighting levels or air-conditioning operation according to building occupancy, and occupants' activity or desired comfort levels. The connected sensors, coupled with IP security cameras, can also help emergency services personnel locate trapped or endangered workers inside a building, or direct occupants to safety.

These innovations are creating new ways for businesses occupying smart buildings to help employees work more efficiently; engage customers and supply chain partners; and make better and more timely business decisions. Further, Power over Ethernet (PoE) drives a large number of the IP-connected IoT devices and allow them to be managed intelligently and harnessed as critical sources of real-time intelligence without batteries.

In-building network convergence

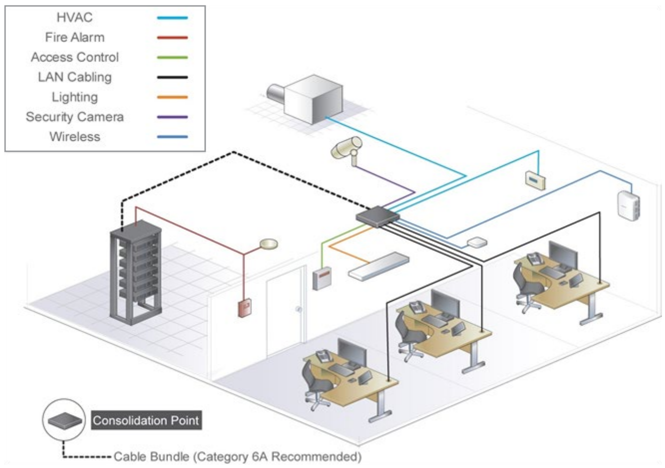
IoT-PoE network capabilities can now be attained with improved cost, reliability and agility through advances in wired (copper and fiber) and wireless (Wi-Fi and cellular) connectivity that integrate real estate, IT, building management and facilities applications into a single converged infrastructure.

The convergence of in-building networks results in a single, intelligent network infrastructure that supports requirements for power and backup power for IoT devices and sensors. A single common infrastructure now supports voice and data communications; in-building wireless solutions; security monitoring and surveillance; power (via PoE); building environmental control automation; traditional operational technologies migrating to IP; and an array of sensor-driven smart building applications that advance the concept of a smart building.

The real intention of this for most advanced enterprises is to avoid a sprawl of dispersed networks – one for each IT or OT system. Essentially, an enterprise has to build at least two duplicated networks – one corporate business network and one building management network. For example, a bank must separate its building network from its highly secure customer banking network.

IoT-PoE network potential

In the IoT-era workplace, a growing volume and diversity of connected devices and services are helping businesses to operate more efficiently and effectively. IoT devices deployed in smart buildings enable applications that increase efficiency of security/access control, fire detection, lighting, HVAC, elevators and other connected systems.



In driving the convergence of traditional facility and IT infrastructures, understanding how to power these sensors and devices efficiently and effectively in a building is a growing challenge.

Active devices in buildings are mostly IP-enabled. They are connected via Ethernet, cellular, Bluetooth Low Energy, Zigbee, Wi-Fi or other protocols, depending on the application and the device. IoT-driven applications rely on the data collected by these sensors and devices, processing and analyzing it to facilitate decision-making.

With governments pushing to minimize carbon dioxide emissions, the efficiency of low-voltage power distribution network inside buildings has become an imperative. And it is being fulfilled by PoE technology that safely transmits low-voltage direct current along with data over twisted pair cabling to remote devices. Such hard-wired, dual-usage installations may incur higher cost than a battery-powered wireless sensor initially but they are more secure and alleviate the time and effort to replace batteries, an overwhelmingly daunting task when dealing with a high volume of IoT devices.

Being standards-based, the Institute of Electrical and Electronics Engineers (IEEE) has gradually enhanced PoE since its introduction in 2003 to power voice over IP systems, CCTV cameras, and radio frequency (RF) ID along with other types of access control devices. The enhanced IEEE PoE 802.3af and IEEE PoE Plus 802.3at that came after has been powering devices that draw more current such as videoconferencing systems, Wi-Fi routers, pan-tilt-zoom or heated cameras, and door interlock systems.

The latest IEEE 802.3bt enhancement brings maximum power to about 90 W, accommodating more types of devices, including even cellular small-cell base stations, retail point-of-sale terminals and digital signage systems.

IEEE 802.3bt, also known as four-pair PoE (4PPoE), increases PoE capacity without compromising data bandwidth. 'Four' indicates the number of wire pairs in the cable used for power delivery. The standard supports legacy 10 Mbps, 100 Mbps and 1 Gbps as well as 2.5, 5 and 10 Gbps connectivity. It also allows power scaling between Ethernet switches and connected powered devices, including the ability to regulate and remotely power down inactive devices for increased efficiency.

The increased power level deliverable by PoE, combined with more efficient devices in general, opens up more possibilities to extend the benefits of IoT throughout smart buildings. Grand View Research predicts that the global PoE market will reach US$3.77 billion by 2025 as more applications and devices utilizing 4PPoE technology are introduced.

Given 4PPoE's higher wattage, Category 6A cabling is recommended for remote powering because it offers lower direct current resistance and improved heat dissipation than Category 5e cabling. Since more current generates more heat, the number of cable runs allowed in a single bundle is an important consideration.

In its R&D lab in Greensboro, North Carolina, CommScope – a global leader in infrastructure solutions for communications networks – is testing and verifying thermal performance and safety of structured cabling systems that support next-generation PoE applications in different real-world installation conditions. The lab is also demonstrating applications such as high-definition security cameras, in-building wireless (IBW) systems and digital signage systems in collaboration with ecosystem partners. Engineers are analyzing the cable's heat emissions in a real-world setting via 4PPoE on SYSTIMAX cabling installed in ceilings and through walls while running these high-power applications.

Integrating wireless connectivity

Deploying a converged infrastructure to support real estate, facilities and IT services in a single architecture promises advantages for dynamic, connected workplaces.

Most cellular calls today originate or terminate indoors. Amid a pervasive expectation of anywhere, always-on cellular coverage for data and voice alike, poor wireless reception frustrates callers, disrupts business-customer communications, and lowers employee productivity.

To ensure ubiquitous connectivity, both Wi-Fi and cellular networks are needed indoors. Cellular coverage indoors augments Wi-Fi connectivity and plays a vital role in enhancing both employee productivity and customer satisfaction.

An IBW solution (i.e. cellular) provides seamless extension of macro wireless networks into indoor space where signals would otherwise struggle to reach. Unlike Wi-Fi, IBW operates on licensed frequency bands used by wireless operators so building operators must ensure that their system supports the wireless operators that occupants use, as well as virtually any frequency bands, including vital public safety bands. Supporting public safety bands may be a prerequisite to obtaining an occupancy license in some countries or regions.

Two main types of IBW solutions are commonly used. Distributed antenna systems (DAS) solutions typically support cellular signals like 2G, 3G and LTE, and connect indoor callers to a number of wireless operator networks. Small cells are typically operator-specific but may be lower cost. A DAS deployment may be handled by the enterprise, building owner, mobile network operator or a third-party vendor.

Even while wireless connectivity becomes prevalent, a robust wired backbone is still needed to support the backhaul transmission. Wired networks leverage new and existing fiber and copper (twisted pair and coaxial) cabling to connect buildings as well as larger edge devices such as Wi-Fi access points, surveillance cameras, small cells and DAS.

Advanced cabling and switches are needed to support Wi-Fi's continued evolution toward speeds reaching 10 Gbps. New standards for IT structured cabling, such as Category 6A copper, OM5 multimode and singlemode fiber-optic cable, have also facilitated convergence of Wi-Fi and IBW solutions.

The ability for IBW solutions today to employ ordinary Category 6A cable – instead of the more expensive and difficult-to-handle RF infrastructure such as coaxial cabling – has greatly streamlined installations, widened possible applications and simplified expansion. The system's headend (which receives, processes and distributes signals) operates like a conventional IT server and switch.

Indeed, new IBW solutions, including DAS and small cell solutions, now share the same Category 6A and fiber-optic infrastructure used by Wi-Fi, which many enterprises have deployed, for better efficiencies. Once considered viable only in very large venues, they are now very much cost-effective IT-convergent solutions that optimize wireless coverage across the smart building.

These developments ready smart buildings for an integrated approach to enterprise connectivity with a grid-based wired infrastructure as an ideal foundation. Such an approach brings smart buildings closer to fulfilling the potential of emerging IoT connectivity opportunities and the associated increases in PoE requirements.

Structured cabling for dynamic workspaces

In a smart building, the infrastructure for communications networks consists of two basic segments – backbone cabling and horizontal cabling. Structured cabling for a converged network – comprising one Ethernet or fiber backbone carrying voice, data, video and wireless traffic – is the foundation of successful smart buildings and the basic investment on which all connected devices depend.

To deliver the bandwidth required by present and future applications, CommScope recommends OM4, OM5 or OS2 multimode or singlemode fiber-optic cable for the backbone cabling that links horizontal segments to the main server. The choice depends on the distance to be covered.

Category 6A copper cable is recommended for the horizontal cabling that branches out to specific networks on each floor within the building structure. Category 6A is recommended for horizontal runs because of its ease of installation and support for 10G backhaul although an OM5 fiber-optic backbone capable of migrating to 40G, 100G and even 200G is recommended for vertical cable runs that aggregate the 10G or 25G horizontal cables for each floor.

One long-term strategic approach to deploying cable infrastructure in a smart building where tenants frequently reorganize workspaces, or move, add and change connected devices, is the Universal Connectivity Grid (UCG) architecture.

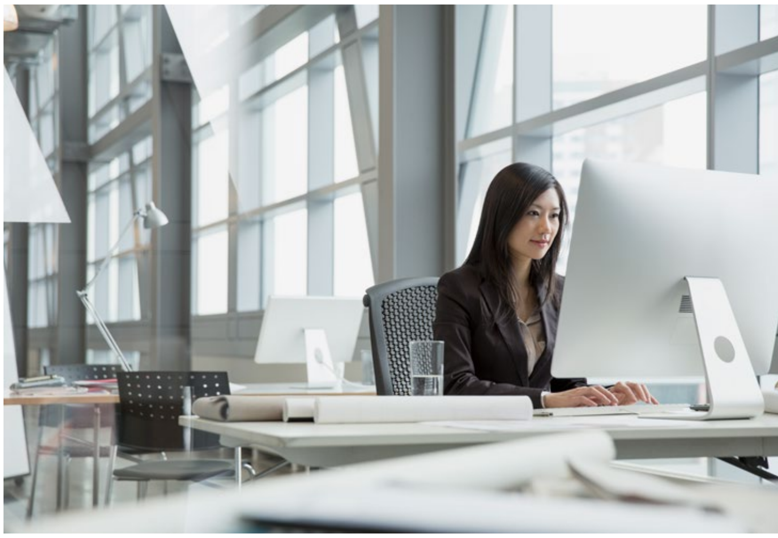
Maximizing flexibility and scalability, a UCG helps with planning for connectivity that is increasingly being deployed in the ceiling space. By distributing a comprehensive grid across the ceiling, the UCG ensures connectivity to every user and device – even when they are on the move – reflecting a shift from a workstation-centric model to a distributed device-centric model.

The architecture uniquely supports low-voltage technologies like PoE and places wireless access points in or near the ceiling, where they can easily and efficiently reach any number of connected devices and equipment without expensive or troublesome modifications.

The UCG's zone cabling architecture ensures horizontal connections are well served by ceiling-based drops, and adequate pathways and spaces for installations and modifications. Ceiling connector assemblies provide a flexible way to integrate wired and wireless technologies such as Wi-Fi, DAS or small cell networks; security cameras and access control systems; LED lighting, HVAC control and occupancy sensors; and digital displays, phone stations or other PoE devices. The use of insulation-displacement connection technology and factory-terminated patch cords alleviates the need to perform field terminations in tight spaces such as those found in a drop ceiling.

Hence, apart from an incremental cost at the initial deployment stage, the pre-cabled grid in the ceiling space clearly offer a cost-effective and flexible way to support common smart building systems such LAN cabling and work stations; telecom or connected devices such as Wi-Fi or IBW access points; fire alarms and security cameras; lighting; building sensors; or remote video screens.

UCG implementation recommendations include a grid layout for high-performance wireless access based on TIA-162-A or ISO/IEC 24704 customer premises cabling; two Category 6A cables per cell for Wi-Fi to provide greater capacity and reliability; and two additional Category 6A cables per cell (one for IBW plus a spare).

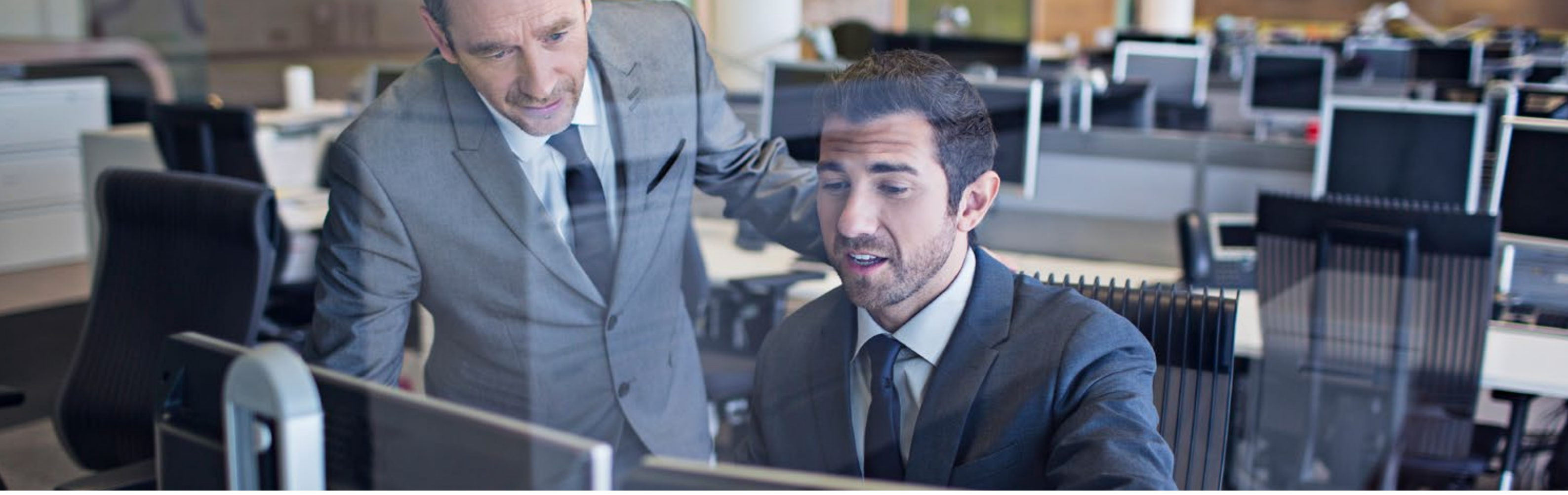


Managing the IoT-PoE infrastructure

A smart building requires an intelligent infrastructure. Building operators and enterprises need quality insights to make smart, real-time communications infrastructure decisions that align with business transformation and growth objectives.

The convergence of in-building networks and the proliferation of PoE-powered IoT sensors and devices connected to the same enterprise network are driving business and workplace transformation for sustainable efficiency and cost effectiveness.

As more sensors are connected within smart buildings, their purpose in the network becomes more critical with the implementation of an automated infrastructure management (AIM) system to harness the output of each sensor to ensure accurate tracking of IT and OT assets, minimal downtime and regulatory compliance.



The AIM system enables the powerful, intuitive control necessary to intelligently deploy and plan for IoT applications requiring PoE, via intelligent patching, guided patching, smart panels and intelligent infrastructure management.

Integrating hardware and software, AIM solutions map out the entire physical infrastructure. They detect any insertion or removal of cords, including any unauthorized or accidental changes. They accurately document the smart building's physical network, including all cabling and connectivity to end devices, right down to the port level. They also enable data exchange with other systems to support smart building applications that require detailed and accurate information to promote operational efficiency and cost savings.

CommScope's imVision AIM system, for example, provides a holistic view of a building's network connectivity and PoE links in real time, eliminating the need for overlay power and management networks.

The imVision AIM system has been enhanced with the capability to keep track of where PoE-powered devices are located while providing more visibility into where PoE services are and can be deployed. This new functionality has become increasingly important as multiple smart building management and control systems are converged and run on the same PoE-IoT network.

The system reveals potential trouble spots, security breaches and underutilized assets that could threaten or undermine business goals and result in unnecessary costs and resources. As a help-desk application, imVision triggers alerts and work orders in real-time, tracking the request process cycle from the opening of a trouble ticket to its resolution. It even provides root-cause analyses of physical network failures for faster service restoration. A good integrated solutions provider can quicken deployments further by providing pre-terminated copper and fiber-optic infrastructure solutions and the skill set to integrate and optimize them.

Additionally, imVision is the first AIM solution to implement cabling standards in TIA, CENELEC and ISO/IEC that establish recommended bundle sizes based on environment and cable categories. It automatically keeps accurate record of PoE installation configurations by tracking and documenting cable bundle sizes and total power carried by each bundle.

ImVision monitors the heat generated within a cable bundle to avoid over heating of any cable in the bundle. It assigns circuits optimally to reduce heat generation and improve heat dissipation for remote power delivery.

By tracking and tracing which ports and outlets are PoE-enabled and enforcing policies like how many cables in a bundle are powered, the AIM solution can reduce operational costs and ensure optimal PoE performance. Alerts are automatically issued when the number of cables exceed the safety threshold defined by the relevant standards.

Just as connectivity is becoming the foundation on which utility companies integrate the urban smart grid with smart cities, connectivity in buildings should also be thought of in the same way as any basic utility like water, electricity and gas. Aligned with this, an AIM-empowered PoE network essentially creates a smart grid for smart building applications. With the convergence of IT and OT systems, smart building networks can tightly integrate enterprise business drivers and goals with the day-to-day load demand, usage and potential effects on the IoT-PoE infrastructure.

Connectivity becomes the necessary utility that makes in-building network convergence, next-generation PoE standards and innovative IoT-driven applications possible. Riding on these technological trends, CommScope's SYSTIMAX physical connectivity solutions and imVision AIM system hold the key to unlocking the power of IoT-PoE networks and maximizing the potential of smart buildings for business and workplace transformation.

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