WHITE PAPER

Networked for Wellness: Connecting Smart and Healthy Buildings

Examine the latest healthy building technologies implemented by building owners and managers, and prescribe the right network infrastructure for connecting a healthy building.

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Study after study shows a correlation between healthy work environments and less sick leave, higher productivity, and greater overall employee satisfaction. For these reasons, healthy building applications have become an integral part of today's smart building initiatives.

Building owners are continuing to make changes to workspaces that incorporate health and wellness initiatives — not only as a response to the Covid-19 pandemic, but as part of an ongoing long-term strategy to improve efficiencies, safety, and employee well-being. A 2021 survey of 400 firms in the U.S. and Canada by Johnson Controls found nearly 60% planned to invest more in healthy building initiatives. These initiatives include clean air efforts and facility systems for remote monitoring, safe access, and building automation.

Emerging technology is playing an essential role in meeting health and wellness goals, and smart building technology like sensors, controls, and lighting are key to enabling a healthy building. Historically, the makeup of a smart building has been generally ill-defined, and as a result is prone to different interpretations. In recent years standards bodies have brought greater clarity, and BICSI has helped build consensus-based standards for smart building infrastructure with ANSI/BICSI 007-2020, Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises.

In addition, the Telecommunications Industry Association (TIA) Smart Buildings Working Group and certification company UL introduced the SPIRE Smart Building Assessment Program in November 2021. SPIRE provides an assessment of connected technologies within buildings, delivering insights, benchmarks, and road maps to help the building owner or operator lower costs, mitigate risks, and enhance overall asset value. SPIRE includes building occupant health and wellbeing in its assessment criteria.

HEALTH AND WELLBEING ASSESSMENT CRITERIA

SPIRE assesses six key areas of a smart building, including health and wellbeing:

- Life and Property Safety
- Power and Energy
- Cybersecurity
- Sustainability
- Connectivity
- Health and Wellbeing

In the Health and Wellbeing area, the SPIRE program evaluates criteria in:

- Indoor air quality
- Thermal management
- Visual comfort and lighting control
- Sound and noise management
- Potable water quality
- Waste and odor management
- Feedback mechanism: input from occupants

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SPIRE scores each of the elements above based on a "three-point" basis, evaluating whether the element is monitored, controlled and optimized for changes, and allowed a greater granularity of control:

1. **Is it monitored?** Collected data provides a window into the performance of the application
2. **Is it controlled and optimized?** There should be a process in place to make changes and improvements based on the captured data
3. **Is there a granularity of control?** Greater granularity of control allows a solution like a thermal management system make changes to smaller segments of a building or floor, as opposed to a whole building floor.

By effectively monitoring and controlling these aspects of a building, organizations can reduce absenteeism, improve employee productivity, and ensure employees are empowered with an avenue for providing feedback.

HEALTHY BUILDING SOLUTIONS

HVAC Controls

One of the key areas of focus for a healthy building is ventilation. It is important to remember that 87% of our time is spent in enclosed buildings, and numerous studies have found that poor ventilation rates directly lead to more instances of sick leave and absenteeism among building occupants. The National Oceanic and Atmospheric Administration estimates that poor air quality results in at least $150 billion in illness-related costs and lost productivity every year in the U.S. alone. On the flipside, workers in well-ventilated offices have double the cognitive function of those in offices with average levels of pollutants, according to a 2015 study by the Harvard School of Public Health.

HVAC controls can monitor air pressure to optimize airflow. It can also ensure there is no ingress of outside air to a specific area that is not filtered or controlled. In addition, humidity and temperature controls can optimize the environment for employees and improve productivity.

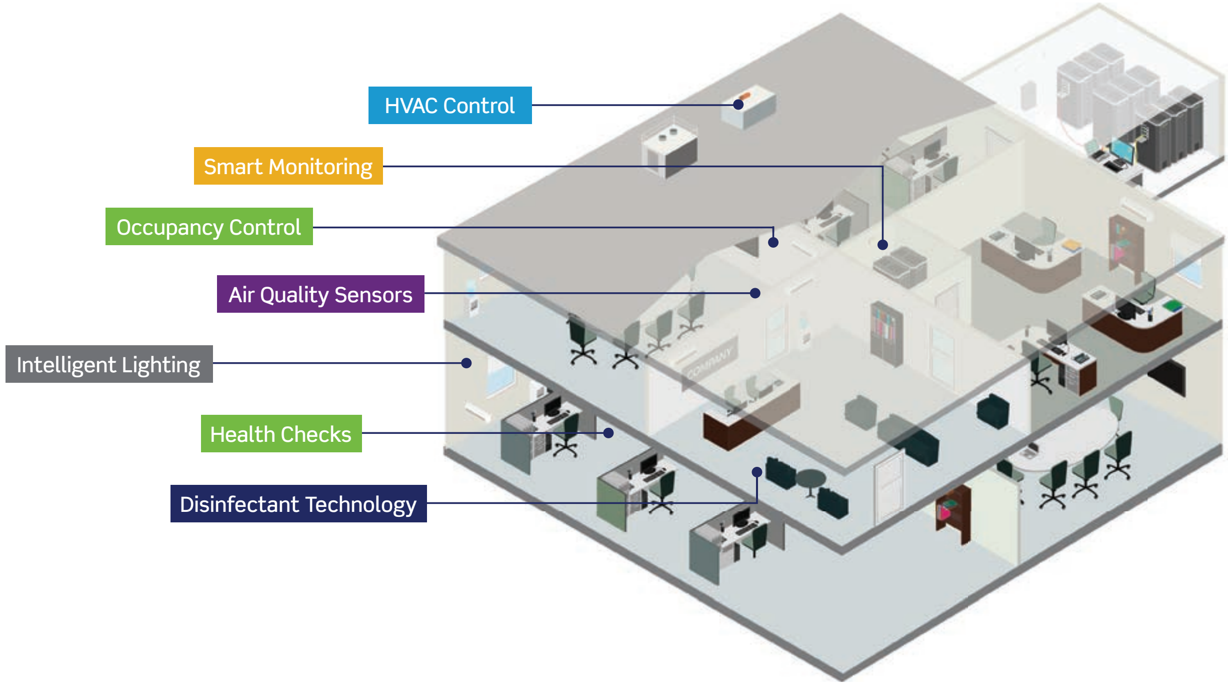
Smart Monitoring of Air Quality

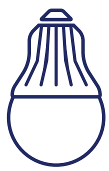
Indoor air quality sensors are being used to monitor CO2 concentration as well as levels of volatile organic compounds (VOCs). Some gases from paints or chemicals used in factories can be carcinogenic to humans, and monitoring VOCs has become an important function in factory facilities.

Occupancy

Occupancy sensors can measure flow of people and alleviate congested areas, or pinpoint areas that require more regular cleaning. Occupancy technology can also improve energy efficiency by controlling unused areas of a building — an increasingly important priority for office buildings with new work-from-home or hybrid workforce policies.

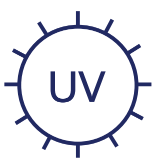
- Occupancy analytics may leverage everything from passive infrared sensors to recognize there are people in a room, to Bluetooth low energy (LE) sensors that can actually count the number of people present. These solutions can monitor occupancy trends over time or create alerts in the case of overcrowding.
- Reservation systems have become a key smart office solution, and occupancy sensors can find the availability of conference rooms and assist with scheduling. This also helps build predictive models of how rooms are used over time.
- Occupancy sensors enable many touchless applications like doors and elevators that can be automated to reduce high touchpoints.





Intelligent Lighting

Lighting sensors can be programmed to adjust light levels depending on the time of day or use daylight harvesting to dim areas receiving sufficient natural light. This not only saves energy but has been shown to improve occupant comfort. Similarly, shade controls are also an intelligent solution that lets in more or less light through windows for a healthier working environment and better climate control.



Disinfectant Technology

Automated disinfectant technology has been introduced that uses ultraviolet light to disinfect surfaces of bacteria or germs. These UV light irradiation systems require areas to be unoccupied, and often work with a building's occupancy sensors to only activate when no one is in the area. While once targeted mainly for healthcare facilities, interest in UV disinfectant technology has expanded to other types of buildings environments as a result of the pandemic. In HVAC ducting, UV lighting or "fogging" disinfectant systems can be used to control air borne illnesses.

CONNECTIVITY FOR HEALTHY BUILDING TECHNOLOGY

In addition to health and wellness, connectivity is another key area that the SPIRE program evaluates as part of a smart building. Connectivity is an essential part of a smart building: No intelligent system can be controlled or optimized without the right connectivity in place, as it is critical for delivering all the information from data input devices to the actuators, switches, system controls, and system software.

A portion of the SPIRE assessment evaluates the connectivity media that is installed. This includes cabling infrastructure like category rated cabling systems and optical fiber, but also wireless coverage like Wi-Fi, 5G, 4G, Bluetooth, and Zigbee. Strong and ubiquitous coverage is important for many healthy building applications to operate effectivity.

SPIRE also considers the security of the connectivity systems. Security and safety processes for IT closets or Telecom Rooms are important, as a service interruption due to unauthorized access or inadvertent disconnection of a building automation system or HVAC control can cause major issues.

Wired Connectivity

Today, 4-pair Ethernet cable is ubiquitous in traditional enterprise networks for Voice over IP phones, wireless access points, and desktop computers. It will continue to be used in the future to connect smart and healthy building technologies, and many of the core applications that connect to the LAN. While 4-pair Ethernet can be found in some building management systems today, historically many of these systems have relied on non-Ethernet protocols such as RS485, Fieldbus, or BACnet. It is anticipated that these protocols may be replaced by Ethernet in the future with the introduction of **single-pair Ethernet (SPE).**

SPE is still in the developmental stage, but it shows potential for use with building automation and IoT devices that require lower data rates. Early SPE standards focused on automotive and transit environments, but the 2020 publication of the IEEE 802.3cg Single Pair Ethernet (SPE) standard created greater interest in this technology for use cases beyond the automotive and transit environments targeted by the two previous SPE standards. The more recent use cases focus on two primary areas: industrial environments and smart buildings. The specific functions that SPE networks will support in both environments are somewhat related since they will likely replace legacy fieldbus networks.

There are numerous industry associations and network infrastructure manufacturers actively promoting the potential of SPE technology to connect HVAC and lighting controls, as well as other Building Automation Systems. SPE will provide power to these devices as well, via Power over Data Lines (PoDL). Many healthy building applications like HVAC actuators, air quality sensors, or temperature controls require smaller data requirements that SPE can sufficiently support. Also, as many of these remote sensors are smaller in size, device manufacturers will be drawn to compact SPE connectivity as an alternative to designing to accommodate a larger RJ-45 plug.

It is likely that SPE cabling will not replace existing 4-pair Ethernet based devices for applications such as Wireless Access Points or IP cameras but will provide supplemental Ethernet-based connections to systems and devices that were previously proprietary or stand-alone. Similarly, it will create a much easier and cost-effective integration of Fieldbus building automation devices, which currently require expensive gateways and proprietary cabling systems. **Figure 1** shows an example of networked systems relying on both 4-pair structured cabling and SPE in the future.

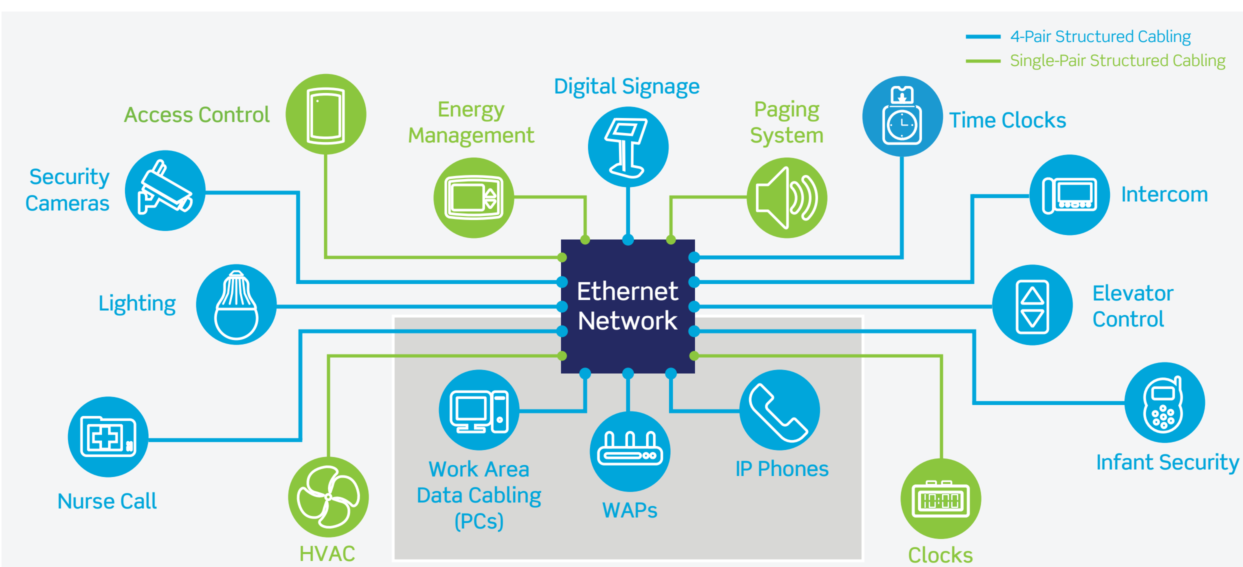


Figure 1: Both 4-pair structured cabling and single-pair cabling supporting smart devices in the future

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While the final cable and connectivity standards for SPE are still in development by ISO/IEC and TIA standards committees, we do know that for smart buildings there will be a single pair cable design that has a reach of 400 meters using a familiar 23 AWG conductor. This will give cabling infrastructure designers the flexibility to use longer runs, which could allow for the consolidation of network equipment into fewer, centralized locations.

Traditionally horizontal cabling within a building is limited to 100 meters. Structured cabling designers understand that if a device will be placed more than 100 meters from the TR, then accommodations must be made in the form of another TR or selecting an alternate media type (typically optical fiber). The extended distances supported by SPE can provide additional flexibility for system designers. For example, an intelligent building may have HVAC equipment located on the roof. Rather than place a TR on the roof, SPE cabling could run to the TR on the floor below.

Wireless Connectivity

Wireless connectivity is one of the fastest growing methods for device communication within the building network. For mobile devices, such as laptops, tablets, and phones, wireless communication is a critical part of the device value. For devices that remain in a fixed position, wireless provides the flexibility to place the device without having to consider the proximity of a data port. A quick and easy way to increase the intelligence and control within building is to replace legacy devices with "smart" devices that communicate wirelessly. Common examples include lighting controls and thermostats.

The latest iteration of wireless access point technology — **802.11ax or Wi-Fi 6** — offers better performance in high-density networks and increases average client throughput speeds. This can create a big boost for smart buildings with ever increasing numbers of building automation sensors and IoT devices joining the network.

Healthy building sensors that connect over Wi-Fi can help reduce the amount of cabling required in the network and make end devices easier to deploy. However, the reliability of device data, especially sensor data, is highly dependent on the reliability of the device connection to the network and its power source. Lost connections can mean the loss of critical data needed for building operations. Many smart building applications will still rely on wired connectivity to support critical infrastructure in the future.

In addition, the biggest advantage wired connectivity offers relative to wireless technology is the capability for remote power delivery. For the quantity and size of many sensors, one power source option is a battery. However, having to replace thousands of batteries in a building would be a maintenance nightmare, as the devices could be located in enclosed or hard-to-reach locations. Therefore, it makes sense to utilize the same cable infrastructure that is delivering data to deliver power and if the device becomes non-responsive, PoDL provides the ability to perform a remote power-on reset.

Zone Cabling Options

A zone cabling architecture can serve as a strong alternative to traditional home run cabling in a smart building. Instead of running cabling from the telecommunications room directly to the work area or device outlet, zone cabling provides a horizontal cable run from the floor distributor in the telecommunications room to a consolidation point enclosure, then to the work area or device outlet. These consolidation points can be passive or active depending on the architecture being implemented, however, as SPE gains traction in the future, we anticipate greater adoption of active zone cabling designs. The active zone allows for a media conversion of 4-pair Ethernet from a telecom room to single pair connections out to the end devices.

With an active zone architecture, a building floor is divided into multiple zones, each with an enclosure that can support an active piece of equipment, including power and cooling. A category rated cable runs from the TR to the zone. Within the enclosure is a switch with an RJ-45 uplink port and multiple SPE ports. In the future, SPE cabling could span out from the enclosure within the zone, ending in a Service Outlet (e.g., SPE jack), or connecting directly to the SPE device, as shown in Figure 2. Depending on the number of SPE ports present, it may be possible for the SPE switch to be powered by PoE from the incoming 4-pair cable.

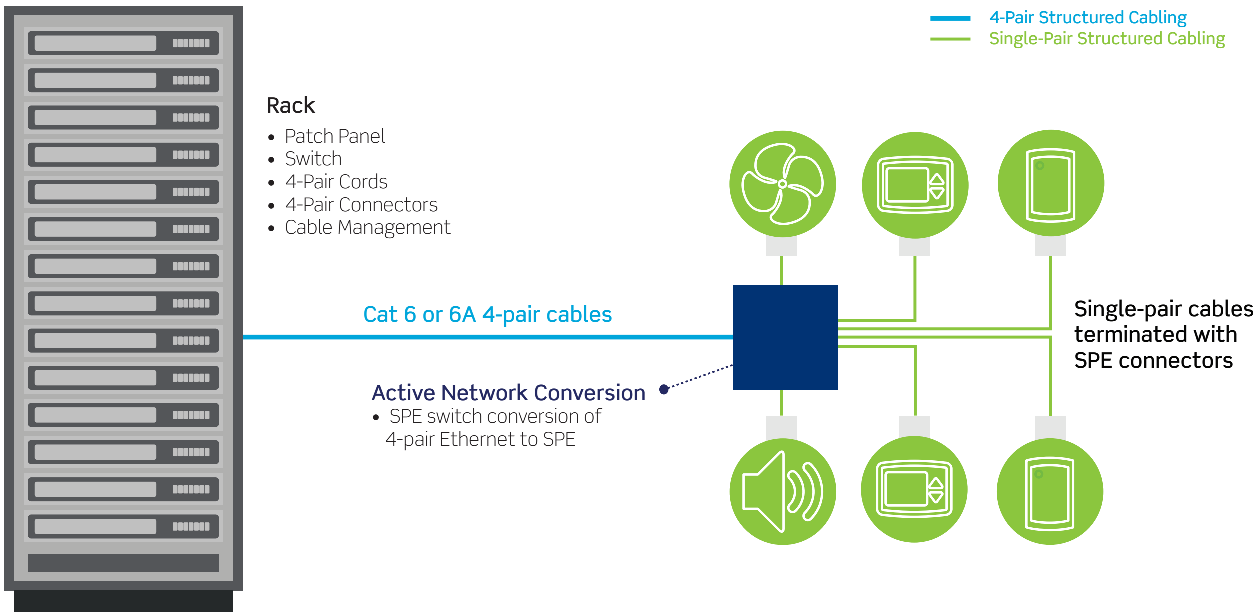

Figure 2: Example active zone cabling design supporting devices with single-pair Ethernet

Active zones are a good choice when there will be a high density of SPE devices within a small area. SPE cable only needs to run to the zone enclosure, rather than all the way back to the TR, and the density of devices will ensure a high port utilization for the SPE switch. This cabling design provides flexibility if new SPE devices are added, or existing devices are moved.

While zone cabling requires the installation of more cables to more locations than a home run design, there are numerous advantages to implementing this versatile architecture. Zone cabling can provide a smart building with a highly flexible cabling infrastructure that offers simple maintenance and the ability to carry out moves, adds, and changes (MACs) quickly and efficiently. It also has a lower cost after installation ("day two" cost). There are, however, several disadvantages to using zone cabling. These include a higher initial cost, fewer measurable benefits to fixed workspaces where MACs are rare, and increased generation of noise and heat by active equipment in active consolidation point enclosures.

Get Guidance

When choosing the right cabling system performance to support healthy building initiatives, both bandwidth and power are important considerations, and there can be a wide range of requirements based on the types of smart devices. Some devices such as occupancy sensors need little bandwidth, while devices like wireless access points may require bandwidth approaching 10 gigabits per second. In addition, smart devices using Power over Ethernet (PoE) may have very different requirements: lighting might require 60 watts or more, while air quality sensors or access control devices may only need 15 – 30 watts. These differences may require different cabling systems.

With so many considerations, network cabling specification and technical experts are more important than ever when undertaking infrastructure upgrades. Leviton experts can provide guidance on the right network designs, intelligent building standards, and appropriate cabling and connectivity for specific PoE enabled smart devices.

In addition, Leviton supports smart buildings with end-to-end cabling systems designed for specific applications, from high bandwidth backbone infrastructure to connectivity for a range of smart devices, including building automation, lighting, security, and more.

Learn more at **Leviton.com/enterprise**.

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