SPIRE 2.0 CONNECTIVITY ASSESSMENT CRITERIA

Enhancing Smart Building Readiness with Support for Emerging Technologies and Trends

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INTRODUCTION

Smart buildings encompass many operational technology (OT) and information technology (IT) systems and devices that provide actionable insights into building performance and building usage. These insights enable data-driven decisions to increase efficiency, optimize operations, mitigate risk, and enhance overall occupant well-being for significant cost savings, improved sustainability, and higher asset value—none of which would be possible without connectivity.

In a coordinated effort with numerous industry experts, the Telecommunications Industry Association (TIA) and UL Solutions launched the SPIRE™ smart building assessment and rating program in September 2020. The SPIRE program consists of an expertly curated, objective, and holistic framework that sets forth technology-agnostic metrics to gauge the ability of a building's systems, processes, and infrastructure to optimize across six major criteria of a facility's function: power and energy, health and well-being, life and property safety, connectivity, cybersecurity, and sustainability. The SPIRE program includes a free online self-assessment for building owners and operators to easily gain insight into their building performance related to the six key aspects. It also has a verified assessment component that results in a rating and detailed recommendations through a performance improvement roadmap.

Since the launch of SPIRE, initial pilot programs, and the development of Version 1.5 assessment criteria, emerging technologies and trends are placing more demands on smart building networks. The number of connected building devices has increased significantly, with one 2023 report estimating that more than 1.5 billion IoT devices were installed in commercial smart buildings in 2022.[1] With more connected devices, the convergence of information technology (IT) and operational technology (OT) systems also continues to increase. With connectivity integral to all building functions and now considered a critical utility—just like water, sewer, electricity, and gas—smart building infrastructure must be designed and deployed to ensure reliable data transmission, cost-effective low-voltage power to devices, and support future expansion and technology adoption.

As industry standards-making bodies, TIA and UL Solutions continually evaluate and improve programs and standards to meet real-life business needs in parallel with the latest market trends, technologies, and the global economy. Emerging technologies and trends, combined with objective feedback from multiple SPIRE Version 1.5 verified assessments and program participant expertise, have called for TIA and UL Solutions to redesign the SPIRE smart building assessment criteria for connectivity. This paper overviews technology advancements and trends impacting connectivity in today's smart buildings. It also outlines how the new SPIRE 2.0 Connectivity Assessment Criteria addresses these impacts and enhances smart building readiness.

EMERGING TECHNOLOGIES AND TRENDS IMPACTING SMART BUILDING CONNECTIVITY

Advancements in technology have increased the number, type, and location of IT and OT devices that comprise smart building systems and how these devices connect, receive power, and communicate via underlying copper, fiber, and wireless infrastructure. Meanwhile, as traditionally siloed IT and OT systems are gradually coming together, they rely on reliable, secure data transfer across multiple onsite and cloud-based platforms to enable interactive applications that help building owners and operators improve efficiency, optimize operations, and enhance overall occupant well-being. As a result, smart building connectivity increasingly needs to support higher bandwidth and expanded coverage, through new communication and power delivery technologies. At the same time, the design and deployment of connectivity and related assets must ensure maximum performance, reliability, security, and resiliency to maintain uninterrupted building operations and facilitate future expansion and technology deployment to adapt to future needs and evolving smart building initiatives.

BANDWIDTH, REACH, AND POWER REQUIREMENTS ARE INCREASING

With more connected devices collecting and transmitting more data about a building and its occupants, smart building networks must deliver higher bandwidth performance. This is especially the case within backbone infrastructure that transmits large sets of aggregated data from multiple systems to onsite and cloud-based platforms for centralized management, analytics, and reporting. Even within horizontal infrastructure, increased migration to IP-based technologies and technology advancements are giving rise to more high-bandwidth end devices. IP-based audiovisual displays (e.g., digital signage, IPTV, video conferencing) and the latest generations of Wi-Fi access points are all extremely high bandwidth end devices, pushing the need for speeds beyond 10 Gigabit per second (Gb/s) within the horizontal infrastructure. Emerging applications such as artificial intelligence, digital twins, and augmented/virtual reality will drive even more bandwidth, which may require the adoption of technologies like fiber optic LAN technologies.

With more connected devices in more locations, the distances that infrastructure must reach also extend beyond the 100-meter (m) distance limitation of industry cabling standards for copper cabling. It's common for smart buildings to need connectivity in more remote locations such as outdoor spaces, warehouses, and parking garages to connect and power everything from surveillance cameras and smart parking applications to Wi-Fi access points and smart lighting. Cellular backhaul technologies, like 5G, 6G or CBRS can be considered as well.

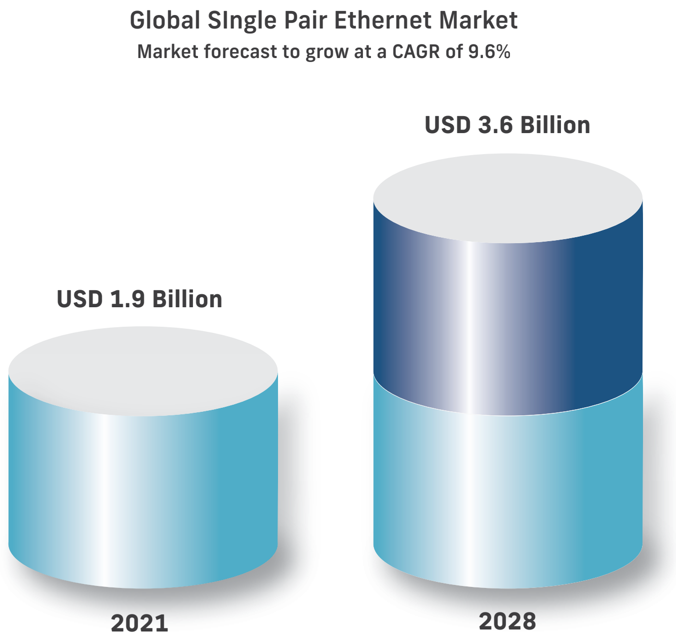
Copper cabling that exceeds standards and offers headroom is increasingly being deployed to connect and power devices to distances greater than 100 m. Device bandwidth and power requirements dictate distance capabilities over copper cabling and depend on manufacturer specifications. It is highly recommended for copper cabling links exceeding the 100 m distance limitation of industry standards to be backed by a manufacturer warranty and tested accordingly.

Connecting devices beyond 100 m can also be supported via hybrid copper-fiber cabling incorporating optical fiber strands to carry data signals and copper conductors to carry DC power. With hybrid copper-fiber cabling, the distance capabilities depend on the power delivery method and the size and number of the copper conductors. For example, a hybrid copper-fiber cable delivering Class 2 low-voltage power can typically deliver approximately 75 W of power to approximately 182 m over two 16 AWG conductors and approximately 457 m over two 12 AWG conductors.

NEW AND EMERGING TECHNOLOGIES WILL IMPACT SMART BUILDING CONNECTIVITY

The need to effectively and efficiently connect and power more IT and OT devices in smart buildings has also given rise to two noteworthy new technologies that will significantly impact smart building connectivity in the coming years—single-pair Ethernet (SPE) and fault-managed power (FMP).

With the ability to deliver up to 52 W of DC power to a device and support speeds of 10 Mb/s over a single copper twisted pair to distances of up to 1000 m—well beyond the 100 m standard distance of four-pair copper cabling—SPE is a viable option for replacing existing proprietary fieldbus connections used in legacy building automation systems. It is ideal for connecting and powering low-speed OT devices, such as actuators, controllers, sensors, and meters used in HVAC, air quality, waste management, lighting, security, and other building control systems. The distances supported by SPE depend on the number of connections, device power requirements, and the size of the conductors. While SPE technology has not yet matured to the point where there is significant commercial availability of equipment and devices, industry standards have ratified



the application, cabling, and connectivity. SPE solutions are expected to start hitting the market in 2024. While the automotive industry already uses SPE technology, the introduction of SPE building automation solutions will contribute to a market growth rate of 9.6% over the next four years, reaching $3.6 billion by 2028.[2]

FMP is an emerging technology for delivering higher levels of safe, efficient DC power to devices in smart buildings. FMP was adopted as Class 4 in the 2023 National Electric Code (NEC) with a peak voltage output of up to 450 Volts (V) with no wattage limit on the power delivered. FMP offers the same safety as Class 2 power-limited circuits such as PoE by limiting the amount of power that can go into a fault but can deliver much higher levels of DC power over longer distances using smaller conductors for materials savings and improved efficiency. FMP currently uses proprietary, UL-listed, transmitters and receivers with centralized management capabilities for monitoring and controlling power parameters. Power and distance capabilities depend on the manufacturer, with one existing system on the market delivering 95 W of power to approximately 1800 m over a pair of conductors and another delivering 300 W to approximately 1200 m over two pairs of conductors.

Like Class 2 power, Class 4 FMP can also be deployed in the same pathway as copper and fiber data cables or in the same cable as in a hybrid copper-fiber cable. FMP-hybrid cables converge power and data over long distances in a single cable, which is ideal for connecting and powering PoE switches, 5G small-cell and DAS antenna systems, high-throughput Wi-Fi access points, smart lighting, and other connected systems throughout a smart building. As more equipment and devices that accept FMP come to market, smart buildings can deploy building-wide connectivity that delivers data and DC power, eliminating the need for much of the AC power in today's buildings. FMP can also connect directly to renewable energy sources (e.g., solar and wind) that deliver DC power, thereby reducing AC to DC conversion that introduces efficiency losses.

PATHWAYS AND SPACES NEED TO ADAPT

Smart buildings increasingly rely on technology and converging IT and OT systems to achieve efficiency and optimize operations, significantly impacting vertical and horizontal pathways and spaces. Allocating and preserving space within pathways for cabling infrastructure and controlled space for system equipment is vital for expansion and future technologies needed to achieve long-term smart building goals.

With the ability to support greater distances in a much smaller footprint than 4-pair copper cabling, fiber optic and single pair Ethernet cabling can be deployed to reduce pathway space and material (e.g., cabling, cable tray, supports). It can also help reduce the square footage needed to support equipment while providing the means to future-proof smart buildings by supporting an increasing number of smart building devices. The space savings afforded by fiber optic and single pair Ethernet cabling is especially beneficial for existing and historical buildings with limited existing pathway and equipment space.

Fiber optic technology, single pair Ethernet, and the increased use of wireless connectivity, as well as the advent of electronics miniaturization and software defined networking, can reduce the need for controlled space to support equipment. However, with OT and IT systems converging, ample space is still needed to support equipment coexisting within the same location. For example, smart lighting is increasingly powered via PoE switches that typically reside alongside IT networking equipment. In other words, equipment rooms are no longer just for voice and data connectivity. It's imperative to allocate equipment space that ensures proper power, cooling, and redundancy to maintain the reliability of both OT and IT system equipment (including security, access control, CCTV, fire alarm, and other systems controls) while providing room for growth. With smart buildings generating vast amounts of data to be stored, processed, and analyzed, space may also need to be allocated for onsite data handling—especially for low-latency applications requiring data processing and analytics onsite in edge data centers versus in cloud data centers.

SPIRE 2.0 CONNECTIVITY ASSESSMENT CRITERIA RESPONDS

Based on new technologies and trends, along with feedback from multiple SPIRE Version 1.5 verified smart building assessments and program participant expertise, TIA and UL Solutions have evolved the SPIRE smart building assessment criteria for connectivity. SPIRE 2.0 Connectivity Assessment Criteria has been updated to include new and emerging connectivity technologies, greater recognition of global standards impacting networks and their design, and improvement of criteria assessment options to better address real-world deployments, physical campus attributes, and regional practices. The updated criteria have also been reorganized and refined with additional explanations and context to prevent conflicting or confusing responses, produce more meaningful results, and streamline the assessment process.

SPIRE 2.0 Connectivity Assessment Criteria are structured as question-and-answer sets, grouped by category into the following sections that provide a straightforward framework that is technology and standards agnostic:

- **Media:** Assesses the bandwidth and low-power delivery capabilities of the deployed media that provides connectivity throughout the building.

- **Coverage:** Assesses support for converging IT and OT functions and adequate coverage for IT and OT systems and devices throughout an entire building and its surrounding property.
- **Security:** Assesses the ability to maintain physical security of building connectivity, infrastructure, and related assets.
- **Expansion:** Assesses the ability of the connectivity and pathways and spaces to support future expansion.
- **Building Resilience:** Assesses the redundancy of the connectivity and policies and procedures needed to maintain critical operations in the case of an event.

The following are examples of how SPIRE 2.0 Connectivity Assessment Criteria responds to the latest technologies and trends within each criteria category.

MEDIA

SPIRE 2.0 Connectivity Assessment Criteria now considers the planned implementation of new SPE technology to connect building automation devices. An annex to address new FMP systems has also been included but does not yet include FMP assessment criteria because the technology is still in its infancy. The media category also now assesses the use of the latest Wi-Fi 6 (IEEE 802.11ax) technology and Wi-Fi infrastructure, including hybrid copper-fiber cables for remote power to Wi-Fi access points. Evidence of manufacturer cabling infrastructure certification and warranty based on industry standards is also considered to ensure that cabling infrastructure meets expected performance levels, which helps determine support for extended distances and future technologies.

COVERAGE

SPIRE 2.0 Connectivity Assessment Criteria addresses the ability of the connectivity to support IT and OT convergence. It assesses wireless coverage to remote and hard-to-reach environments such as stairwells, elevators, parking garages, and the surrounding property. The criteria also consider planned implementation of the latest 5G cellular service and private wireless communications for enhanced security and coverage.

SECURITY

SPIRE 2.0 Connectivity Assessment Criteria addresses the physical security of equipment spaces, pathways, and connectivity assets to prevent unauthorized access, including practices such as access monitoring and asset tracking. The criteria also address the ability to secure critical operational systems via separation from other systems, either physically or virtually.

EXPANSION

SPIRE 2.0 Connectivity Assessment Criteria addresses the capacity of pathways and spaces, bandwidth consumption awareness, backup power availability, and new technology assessment policies to accommodate future needs and expansion.

BUILDING RESILIENCE

SPIRE 2.0 Connectivity Assessment Criteria addresses building resiliency by evaluating redundancy, backup and disaster recovery, and processes for monitoring, maintenance, troubleshooting, and recovery.

GET STARTED CONNECTING YOUR SMART BUILDING

As bandwidth, reach, and power demands continue to grow, and new and emerging technologies enter the marketplace, proper design and deployment of smart building connectivity will be vital to supporting current and future technology needs.

As a straightforward, agnostic, and streamlined framework for the built environment, SPIRE 2.0 Connectivity Assessment Criteria is ideal for smart buildings to assess the capabilities of their connectivity and underlying infrastructure and identify the steps to ensure support for future needs. The enhanced connectivity assessment criteria, along with the other five assessment criteria of SPIRE— power and energy, health and well-being, life and property safety, cybersecurity, and sustainability—empower smart building owners and operators to identify, prioritize, and optimize performance from a holistic perspective that results in significant cost savings, improved sustainability, and higher asset value.

SPIRE 2.0 with updated cybersecurity, connectivity, and sustainability assessment criteria is now available. Get started on the journey today with a quick, easy, and FREE of cost SPIRE Self-Assessment or contact us to learn more about how a SPIRE Verified Assessment can improve and optimize the performance and value of your building.

Interested in participating in TIA's Smart Building Program to help develop SPIRE holistic assessment criteria and shape the future of smart buildings? Contact us today at membership@tiaonline.org.

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TO LEARN MORE ABOUT SPIRE 2.0 CYBERSECURITY ASSESSMENT CRITERIA

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