Toward Smart Building 5.0

A technology vision for regenerative buildings

White Paper
Toward Smart Building 5.0: A technology vision for regenerative buildings

Alcatel·Lucent
Enterprise

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Enabling tomorrow's regenerative Smart Building 5.0

Advanced technologies have enabled the creation of smarter residential, commercial and industrial buildings. Initially, digital technologies were integrated to provide connectivity and automation. Later, the adoption of Internet Protocol (IP) from the core to the endpoint allowed for the deployment of IoT sensors and devices to collect data from everywhere to support more efficient building operations. Building management platforms that took advantage of cloud infrastructures and software as a service (SaaS) models were introduced to streamline monitoring, maintenance and management processes. And machine learning (ML) and artificial intelligence (AI) systems were adopted to provide actionable intelligence to inform everything from building conception to building operations.

Today's Smart Building 4.0 is built on operational technology (OT) and information technology (IT) systems that provide the backbone for IoT and AI devices controlled by centralized intelligence and management platforms. This technology backbone is critical in the construction and operation of smarter and greener buildings, which use automated systems that can be programmed to reduce the building's environmental impact through more efficient use of resources.

The adoption of advanced technologies for smart buildings is expected to continue for some time. By 2026, 115 million buildings worldwide are expected to use smart building technologies, up from just 45 million in 2022[1]. Beyond 2026, deployments will continue to increase to keep pace with increasing population rates and rapid urbanization trends that will see 70% of the world's population shift to urban areas by 2050[2]. During that time, today's $117.42 billion global market is projected to grow to $568.02 billion by 2032, at a CAGR of 21.8%[3].

The nature of smart buildings is expected to evolve within that timeframe. The envisioned next generation of smart buildings will go beyond reducing their impact on the environment. They will contribute to healing and restoring the environment through regenerative architectures that have a much larger environmental reach:

> **"In contrast to sustainably designed buildings, regenerative buildings are designed and operated to reverse ecological damage and have a net-positive impact on the natural environment. Shifting from a sustainability lens to a regenerative one means that architects should question how we can design structures that not only use limited resources but also restore them."[4]**

From a technology point of view, in addition to more efficient management of energy consumption, Smart Building 5.0 will use digital technologies that enable regenerative architectures to improve the ecosystem, enhance biodiversity and replenish natural resources.

Achieving these objectives requires a significant evolution of current smart building technology infrastructures. Today's programmable, hyper-aware infrastructure automated by AI and operated by siloed management platforms must become more powerful. A more integrated digital infrastructure will be needed that is autonomously controlled by distributed intelligence and operated with a single, unified management system.

1 "Smart Building Deployments to Exceed 115 Million Globally in 2026", Juniper Research, March 2022.
2 "Smart Building Market Size, Share & Analysis", Fortune Business Insights, August 2024.
3 "Smart Building Market Size, Share & Analysis", Fortune Business Insights, August 2024.
4 "What is Regenerative Architecture? Limits of Sustainable Design, System Thinking Approach and the Future", ArchDaily, March 2023.

A single, integrated technology infrastructure is needed

Today's Smart Building management platforms are built with independent, siloed OT systems. Typically, they are designed to manage key building functions such as heat, ventilation and cooling (HVAC), lighting, energy, security and air quality based on collected sensor data and pre-programmed automation. Interoperability is a key requirement because each of the silos may use a different technology protocol.

The evolution to current information platforms has been driven by the availability of IP and Ethernet, the introduction of IoT and the availability of cloud-based computing. Cloud solutions provide the computing power needed to efficiently manage and process the huge volume of data generated by multiple independent systems. And most of today's smart building information platforms are built on cloud-based technology provided through a SaaS model.

Smart Building 5.0 will include more complex operating systems than those needed to support today's smart building environments. The regenerative architecture of the next generation of smart buildings will have a more biophilic design, which will include things like green roofs and green walls that will enable the building to have a positive impact on its environment (Figure 1). To optimize that impact, the elements of a regenerative architecture will require more precise, ongoing and effective management of supporting systems like solar panels, watering networks, water supplies and water recycling. These systems will generate and require management of exponentially more data than today's information platforms deal with.

Figure 1: Moving from smart spaces to regenerative spaces

The best way to support all the systems in a building and efficiently manage and process all the data that will be generated is with an integrated technology infrastructure that takes the capabilities of today's information platforms to the next level. This new infrastructure must:

- Connect all technology silos in a building into a single, integrated system
- Operate on a single protocol (IP)
- Provide the middleware layer needed to interconnect all the disparate apps and software that will enable the seamless exchange of data with all connected endpoints and subsystems, similar to an operating system

Decentralized, intelligent computing is key

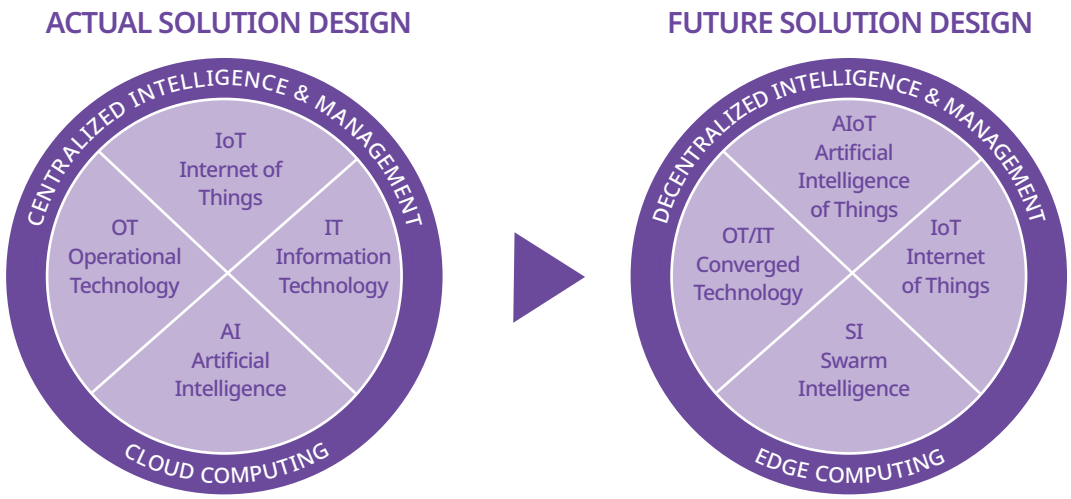
A single integrated technology infrastructure is needed

The proposed integrated technology infrastructure for Smart Building 5.0 will require edge computing that can provide more computing power at the edge where sensors and regenerative systems live (Figure 2). AI will still be needed, but rather than a centralized, cloud-based AI that operates in remote data centers, the infrastructure will require AI at the edge or even in the end points as AIoT.

With AIoT, the infrastructure will take advantage of swarm intelligence capabilities to enable efficient operation of IoT devices and improve data management and analytics at the edge. It will also support the introduction of autonomous, intelligent operations of IoT devices without the need for centralized, cloud-based data processing.

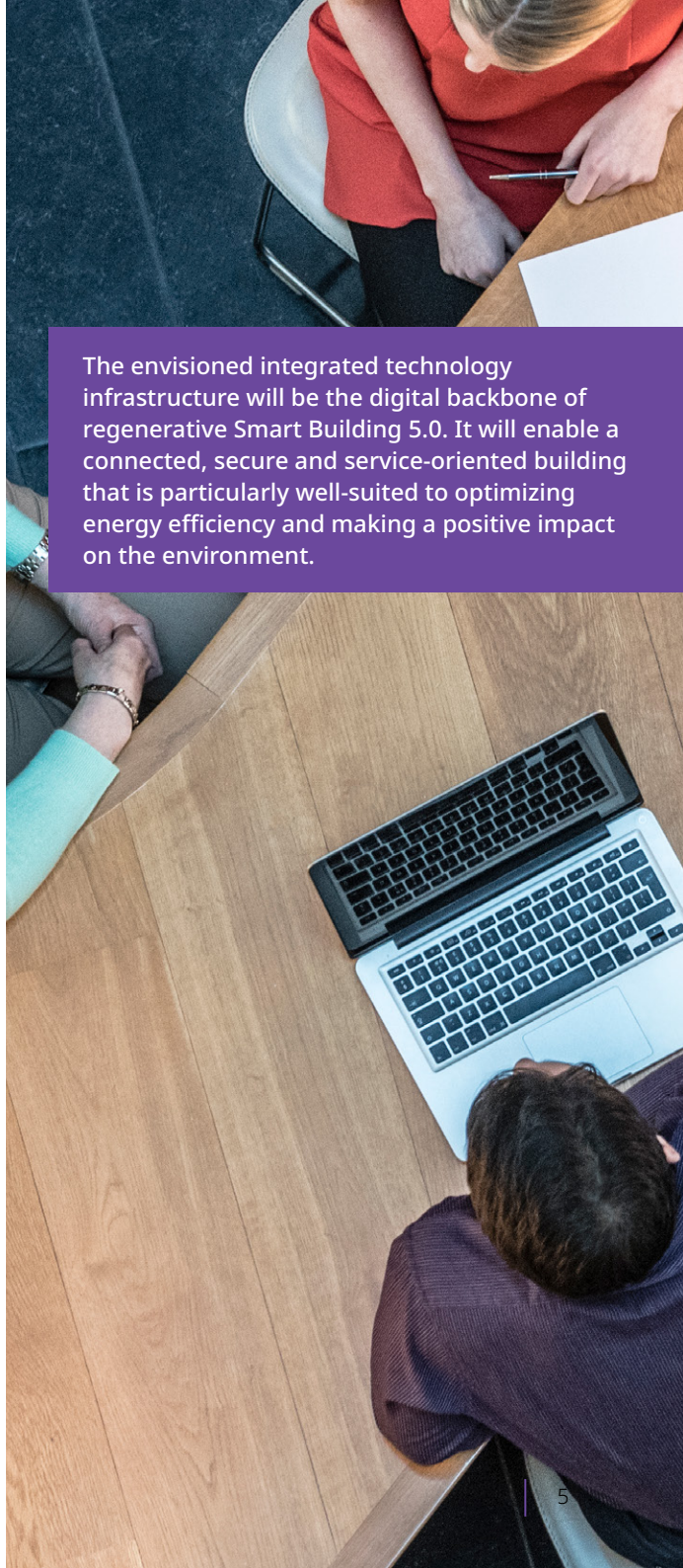
Of course, OT and IT systems will still be key components of this technology infrastructure. But rather than continuing to operate as independent silos, these systems will merge into a single system that interacts seamlessly with all IoT elements.

Figure 2: Smart Building 5.0 technology enablers



A single technology backbone will manage everything

With this integrated infrastructure, Smart Building 5.0 will manage temperature, lighting and window shades room-by-room using multiple sensors. It will leverage its truly intelligent architecture to collect data, analyze it, report it and independently act on all the information available to support ongoing operation. In addition, the building will be able to predict changes in operating parameters that are needed based on data about in-building and exterior environmental conditions and act on those predictions as needed to maintain regenerative building objectives.



The envisioned integrated technology infrastructure will be the digital backbone of regenerative Smart Building 5.0. It will enable a connected, secure and service-oriented building that is particularly well-suited to optimizing energy efficiency and making a positive impact on the environment.

Achieving technology objectives

Enabling the creation of the integrated technology infrastructure for Smart Building 5.0 will require all stakeholders to overcome a few challenges. While it is difficult to accurately predict all the challenges that must be overcome, we can expect that some of the key challenges may be like those faced with realizing the full potential of Smart Building 4.0:

- Alignment of the key stakeholders — owners, developers, tenants and operators — on objectives and outcomes from conception to delivery
- Economics associated with achieving smart building certifications that will emerge, such as SmartScore, R2S and others
- Compliance with a variety of regulations at the local and country level

We can also expect a few technological challenges on the road to a single, integrated technology infrastructure with a distributed intelligence.

For example, merging today's siloed OT and IT systems will be a challenge. Likewise, federating all the subsystems, endpoints and platforms through a middleware layer that provides a similar function to that of an operating system requires a new way of thinking about how software can be leveraged to enable regenerative operations. The adoption and integration of AIoT with a decentralized swarm intelligence network will present additional challenges. Creating or adapting a unified management platform that provides a single-pane-of-glass view to simplify management and operation will be an ongoing process. And as with all digital systems, security challenges will emerge because more interconnected systems lead to more potential points for cyberattacks.

The solutions to all these challenges cannot be identified today – and many more will emerge. But just as the challenges present themselves, new technologies and new approaches will be developed to address them. Resolving the technology challenges will require the expertise of Smart Building Digital Advisors who can provide the guidance needed to develop practical parameters for the technology infrastructure.

Alcatel-Lucent Enterprise enables the digital evolution to Smart Building 5.0

Alcatel-Lucent Enterprise understands what it takes to enable today's Smart Building 4.0. Our Digital Age Communication (DAC) and Digital Age Networking (DAN) solutions can be used to create hyper-aware Smart Building 4.0 infrastructures by enabling the seamless integration of OT, IT and IoT at all three layers of the technology stack — physical, communication and application. These solutions provide the digital foundation needed to enable smarter buildings (Figure 3).

Our expertise with these technologies and experience delivering Smart Building 4.0 solutions worldwide can be leveraged to develop the next generation of digital solutions that enable a single, integrated technology infrastructure with a distributed intelligence for Smart Building 5.0.

Our track record of innovation provides the knowledge and expertise needed to work with all Smart Building 5.0 stakeholders to develop the technology roadmap that will enable the move from connectivity to intelligent networks and communications. And our extensive ecosystem of technology partners is available to provide additional insights in everything from OT and IoT to software and services.

Contact Alcatel-Lucent Enterprise to learn more about how you can leverage OT, IT and AIoT, edge computing and swarm intelligence to create a single, integrated technology infrastructure with a distributed intelligence for Smart Building 5.0.

Learn more about how Alcatel-Lucent Enterprise can help you with your smart building project.

Figure 3: Alcatel-Lucent Enterprise provides the digital foundation needed to enable smarter buildings

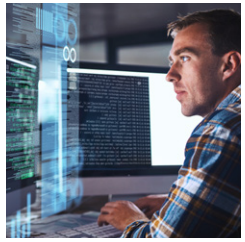
Smart networks

- Zero trust network
- IoT management
- Unified service platform
- Predictive maintenance (AIOps)
- IT/OT convergence
- Macro/micro-segmentation
- PoE management

Smart wireless

- Controllerless Wi-Fi
- RTLS (Real-time location services)
- Passive and active heatmap
- Smart analytics
- Wi-Fi 6/6E/7, BLE, Zigbee
- On premise or cloud management

Smart platform



- Rainbow CPaaS
- Data hub
- Workflow management
- Contextual data
- UC of Everything

Smart ecosystem

- Development and service partners
- HPOL / GPON / XGS-PON / 25GS-PO - FTTO
- SDK and sandbox access
- Third party integration (API)
- VMS plugin
- LoRaWAN gateways

We provide secure networking and communication solutions enabling organizations and industries to accelerate their operational efficiencies and competitiveness. In the Cloud. On Premises. Hybrid.

Alcatel·Lucent Enterprise