

Achieving Financial and Functional Advantages  
in Connected Building Solutions  
with the Unified Physical Infrastructure<sup>SM</sup> (UPI)



WHITE PAPER

## Introduction

IP-based communication is making a revolutionary impact on the process of building design, construction, and operation. According to Forrester Research, an estimated 14 billion devices are predicted to be connected to the Internet by 2010,<sup>1</sup> with many of these devices operating in buildings as controllers, sensors, servers, and microprocessors. This progressive change in building systems make-up provides an opportunity to achieve higher asset utilization within an improved cost structure while simplifying building operations and management and increasing green performance.

Building stakeholders are increasingly utilizing Unified Physical Infrastructure<sup>SM</sup> (UPI) principles to drive interoperability and convergence of building devices and systems that formerly would be separately deployed and managed through proprietary closed technologies. These new intelligent infrastructure design strategies reduce operational expenses with no additional capital costs to fulfill the requirements of current day building systems and provide a flexible migration path to adopt future technologies. Integrated building systems also contribute to core sustainability objectives by managing energy resources more effectively, reducing waste and shrinking the organization's carbon footprint.

Specifically, connected building planning requires tightly integrated, well-coordinated cross-functional communication and project management across four functional phases: organizational alignment, technology strategies, network design considerations, and financial analysis. By optimizing the planning process at each phase, stakeholders can develop a property that enables flexibility for corporate and commercial use, achieves greater operational efficiencies, and contributes to sustainability and security initiatives.

## UPI-Enabled Connected Building Strategies

Almost every building system (HVAC, lighting, security, and communications) uses some form of IT networking for management and control. The technologies for connecting, managing, and automating building systems include servers for hosting management software and controllers for floor level settings. Components can include a wide variety of endpoint devices (such as lighting, variable air volume [VAV] boxes, surveillance cameras, and interactive lobby kiosks) as well as required network infrastructure (cabling, switches, connectors, and related protocols).

The growing interdependence of building system technologies and applications requires the integration of many traditionally disparate and proprietary systems. The UPI approach to physical infrastructure design helps stakeholders manage the risk within the physical infrastructure by intelligently converging physical and logical systems to build a smarter, unified business foundation. This approach uses an open standards-based framework to align, converge, and optimize critical systems – communication, computing, control, power, and security – to deliver tangible infrastructure and business process improvements.

Connected Building Solutions realize UPI design principles in the form of an intelligent infrastructure that extends throughout a property to both connect technology components and bridge stakeholder needs. These solutions enable linked facility and network systems to be built directly into the building fabric, generating and sharing data over a unified intelligent infrastructure to enhance building efficiency and effectiveness. The completed infrastructure enables building owners and property managers to reduce occupancy costs and enhance workplace experiences for their tenants or employees, and ultimately manage property resources more efficiently.

Successful connected building projects result not from following a fixed set of instructions, but from engaging in an open dialogue between stakeholders and partners at every stage, leveraging knowledge across the organization and vendors to reduce communication gaps. Industry standards and UPI-based reference architectures can support customized approaches to deploying specific systems and technologies. However, no matter what level of customization is used, stakeholders can realize higher asset utilization from their investment by following UPI best practices at each phase of the building's life cycle (see Figure 1).



**Figure 1. Four-Phase, Cross-Functional, Multi-Disciplinary Approach for Developing a Connected Building Solution.**

## Organizational Alignment

Connected building project leaders should leverage both *internal and external* expertise and align these resources throughout all project phases to the strategy and goals for the development, including key corporate objectives such as security, sustainability, and operational efficiency.

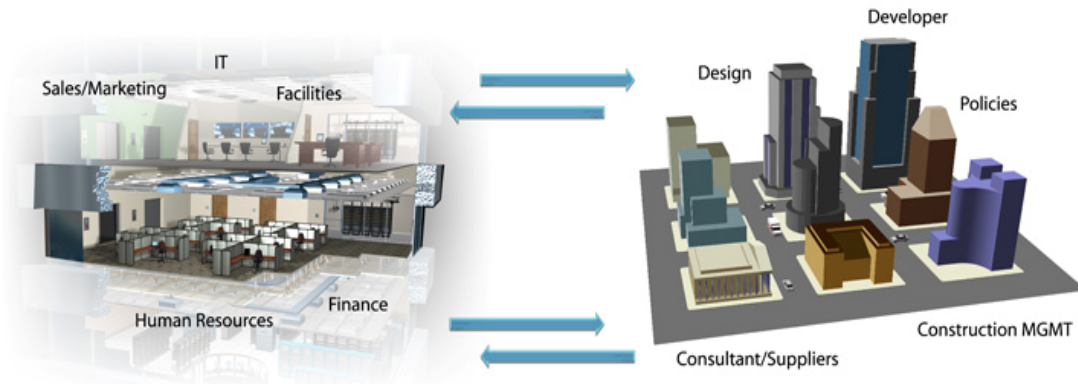
### Internal Alignment

The internal alignment process leverages the skill sets of the broader organization to ensure that the business needs of the organization are met (see Figure 2). Strategy leadership for the project should educate and align the team on the project goals as well as the benefits of modern building systems. Leadership also should hold regular internal, cross-discipline committee meetings and appropriately allocate resources to the project.

Modern building design and operations involve finance, IT, facilities/operations, security and HR as well as sales and marketing. Also, internal stakeholders may differ from organization to organization, but will nearly always include an executive sponsor who champions the work of these groups.

### External Alignment

Connected building strategies drive the external alignment process by building on the strength and depth of vendor relationships (see Figure 2). The key to successful external alignment is for the owner or executive champion to develop a strategy that considers peripheral and downstream impact, and then gain alignment on this strategy from key contributors. These contributors include architects; engineers, such as Mechanical, Electrical, and Plumbing (MEP) engineers; consultants; contractors; and manufacturers of controls systems, such as building automation, lighting, security, and IT infrastructure.



**Figure 2. Connected Building Shared Project Model**

Owners should work with contributors who recognize that silo thinking represents a significant project risk. Each key contributor should be expert in their field and should understand how current technology developments integrate with other systems and technologies in complementary fields. Contributors continue to focus on their areas of expertise, with their efforts directed and unified under the strategy established by the owner/champion.

Also, the external communications process should mirror the internal communications process, and include regular committee meetings, conference calls, and webinars between the different disciplines and vendors. Process specifics include regular education sessions, information sharing, and validation of operational cost budgets.

Finally, the connected building external alignment process often utilizes attributes of holistic or design thinking to account for downstream impact such as total cost of ownership (TCO), facility management, and occupant experience. Several tools have been developed to support modern building design, with two well-known examples being the AIA California Council's Integrated Design Process and the Construction Specifications Institute's (CSI's) MasterFormat™ 2004 (see sidebar).

**About: CSI MasterFormat 2004**

*MasterFormat 2004 Edition (MF04) was published by the Construction Specifications Institute (CSI) and Construction Specifications Canada (CSC) in the fall of 2004. Release of MF04 marked a significant change in the construction industry as a new 50-Division organizational structure replaced the familiar 16-Division structure that dates back to 1964. Reasons for change are documented in the print version of MF04, as well as how change was minimized where possible.*

*The expansion of the numbers and titles is a masterful response to keeping pace with a dynamic built world that continues to add complexity and new work results. What may be surprising is how MF04 opens the door to perspectives beyond traditional building construction, as significant enhancement has been provided in looking at holistic facility life cycle needs.*

*(Source: CSI MasterFormat™ 2004 Edition Implementation Assessment)*

## Technology Strategies

The technology strategy of a connected building starts with an acknowledgement of the pervasiveness of IP networking in current day building construction. Manufacturers of building automation, lighting, security, and audiovisual (A/V) systems are increasingly building their controls to integrate with IP networks.

An early design commitment made across several connected building technology areas has a significant impact on the ability of stakeholders to meet downstream timeline and budgetary goals. Unless all key contributors are aligned with the technology vision and decisions of the owner/champion, the risk of cost overruns and operational inefficiencies increases significantly. The rest of this section discusses the strategic technology areas and key elements of successful connected building projects.

**Sustainability Objectives.** Core sustainability objectives include reducing consumption of non-renewable resources and creating healthy environments. Physically converged infrastructures contribute toward larger corporate green initiatives by leveraging real-time information across integrated building systems to automatically manage energy resources more efficiently. For example, building managers can match energy inputs to the requirements of occupants and the building environment, providing the optimal amount of comfort to users while minimizing wasted energy.

Smart lighting systems, electrical sub-metering, daylight harvesting, and modern underfloor Heating, Ventilating, and Air Conditioning (HVAC) are used to improve occupant comfort and achieve energy efficiencies throughout the building, thus shrinking the organization's carbon footprint. Such solutions also add value by enabling green performance and U.S. Green Building Council LEED Certification for building stakeholders, which contributes to the "Double Green" effect of being both good for the environment and financially advantageous to building owners.

**Interoperability Strategies.** To achieve the goal of network interoperability, connected building technology strategies ideally should require all building systems to operate on open protocols. This approach enables communication between core building systems and opens the door for true building system alignment, convergence, and optimization. Deployment of IP-enabled systems and endpoint devices is projected to grow at double digit rates while closed and proprietary systems decline (see Figure 3).

Open protocols are available for all traditional building control systems (lighting, HVAC, and electrical, etc.) that can easily coexist and interact with IP-based technologies. Although not all building systems are natively IP, all non-native IP systems should have a migration path for connecting to an IP network.

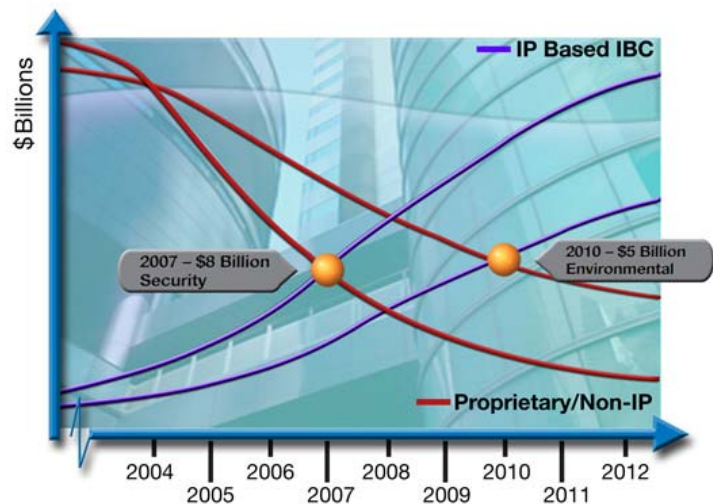


Figure 3. Forecast World Growth of Intelligent Building Control (IBC) Systems<sup>2</sup>

**Converged Networking.** A flexible, converged physical infrastructure is the foundation of all Connected Building Solutions. UPI principles enable the convergence of building systems and IP networks within a single pathway, allowing a robust building network to share the same telecom spaces and pathways. This strategy simplifies future changes to the space, reducing the time required for configuration refresh cycles and easing the deployment of new systems and technologies.

This flexibility equips owners with the maneuverability to effectively select building system vendors and components on a timeline that maximizes business agility. Further, network backbones designed in compliance with current telecommunications standards (TIA-568, -569, and -942) are easier to manage and maintain, sustaining growth and change while providing many years of service.

## Networking Design Considerations

Although nearly all building control systems utilize IP networking, not all design and engineering firms possess the latest knowledge on technology options and requirements. This gap creates an opportunity for IT professionals to provide owners and developers with expertise in the following areas, to support system connectivity requirements while allowing traditional trades and contractors to stay focused on their core business.

1. Converged physical infrastructure that enables the integration of control systems with the IP network, and extends the reach of the IP-based network to all Internet-enabled devices.
2. Logical network for connecting all control systems and IT applications.
3. Middleware for integrating building infrastructure and IT applications over a common IP network to enable true system interoperability and limit proprietary service requirements.
4. Data center sized for building systems, which organizes previously disparate systems' servers and related equipment in an efficient footprint.

**Converged Physical Infrastructure.** Connected building architectures provide a platform for secure, scalable and interoperable systems throughout an enterprise. Most systems can be physically converged through shared conduit, cable trays, and building pathways; others will converge logically through a switched IP network. By capturing and transporting all operational and services data over a physically converged network infrastructure, it becomes possible to implement facility policies that support business requirements and tenant/customer needs.

The common denominator for converged building systems is the expansive reach of the cabling infrastructure and physical connectivity. This converged multi-technology backbone is comprised of copper, optical fiber, coaxial, and fieldbus cabling, to connect a wide range of endpoint devices including surveillance cameras, climate controls, and energy management sensors. By connecting and harmonizing critical systems and devices, owners can optimize building energy use and manage risk into the future.

Building systems are converged within a common pathway and then terminated within zone enclosures distributed throughout the building. The zone enclosures become network consolidation points, allowing all cables to be managed and patched in a single enclosure, enabling building system networks to be converged within Ethernet cabling pathways during the design phase. This architecture differs from dedicated cabling runs typically used in building systems, in which multiple lengthy and redundant cabling routes along disparate pathways, leading to inefficiencies in specification, installation, and maintenance.

***UPI Architecture Realized in New PANDUIT World Headquarters Building***



***The new PANDUIT World Headquarters Building in Tinley Park, IL USA will provide state-of-the-art visibility and control of all critical building systems, integrated and aligned under a single unified intelligent infrastructure.***

*When planning its new World Headquarters Building, PANDUIT project leaders invested in a UPI-based Connected Building Solution to enable convergence of facility systems onto a single network for improved control, communication, and management. This unified approach to infrastructure architecture offers advantages to owners, employees, visitors, and guests:*

- *Improved building system management, providing greater visibility and control of critical systems that identify, monitor, and resolve problems before they affect workers, enhancing overall security and safety.*
- *Converged networks that enable enhanced commissioning and help meet energy performance requirements for LEED Gold certification.*
- *Multi-technology architecture that extends the reach of cabling infrastructures to all end point devices, creating seamless integration of building systems including IP telephony, wireless connectivity, digital media and unified communications.*
- *Converged infrastructure design to reduce initial deployment and maintenance costs throughout the lifecycle of the building.*
- *Flexibility to accommodate changing user needs, from mobility services to environmental controls.*

*The new facility will enable collaboration through unique design features ranging from open office concepts, shared work spaces, and the deployment of the latest tools. Also, to provide a healthy workplace and minimize our ecological footprint, PANDUIT will achieve Leadership in Energy and Environmental Design (LEED) Gold certification, reinforcing our commitment to the environment and delivering significant energy savings.*

These design strategies impact the layout of electrical, mechanical, and telecommunications rooms by optimizing layout space and reducing cooling and electrical requirements. With each additional building system routed within the same pathways and enclosures, network cabling becomes easier to locate, manage and maintain; this approach also helps eliminate abandoned cable in ceilings. Additionally, these strategies should be applied to outside plant (OSP) facilities, with the OSP managed as a real estate asset that considers right of way and easement policies.

**Logical Network.** The IP network will be as flexible and scalable as the physical infrastructure and accommodate nearly all IP and fieldbus connectivity between controllers, management servers and across building systems. Each endpoint device that requires an Ethernet port can be tallied to estimate initial requirements for logical network capacity. Each device also requires a defined level of bandwidth: lighting control commands and temperature control readings use very little bandwidth whereas security surveillance requires substantially more.

Additional network flexibility can be realized by taking advantage of Power over Ethernet technology. PoE extends the capabilities of Ethernet by delivering both data and reliable DC power over the same cables to endpoint devices such as VoIP phones, access control and surveillance cameras, and wireless access points. Because PoE converges data and power together over the same cable to each device attached to the local area network, devices can be installed without the need for a dedicated AC outlet. This saves money by eliminating the cost and time associated with AC outlet installations, while providing the flexibility to locate PoE devices where performance is optimum.

**Middleware.** Intelligent middleware technology transforms building operational data into information that provides owners deeper visibility into building systems. By integrating building infrastructure and IT applications over the same logical IP network, intelligent middleware technology enables sophisticated monitoring of energy consumption so building stakeholders can improve business decisions, achieving greater energy savings and improving operational efficiencies.

Note: It may be necessary to augment existing systems or predetermined system protocols with middleware appliances or services to normalize proprietary environments and to enable them for back office system consumption and analysis.

**Data Center.** A Connected Building Data Center (or CBDC) leverages TIA-942 best practices to organize previously disparate building systems' servers and related equipment in an efficient footprint. This represents a new step forward in the evolution of building system design: rather than leaving servers, demarcations, and connectivity points scattered across utility closets, in ceiling tiles and hung on boards, the connected building design team should plan an organized environment for building system active equipment that optimizes real estate and is supported by adequate power and cooling.

Unlike traditional data centers that run applications to handle the core business and operational data of an organization (such as ERP and CRM systems), CBDCs are sized to maintain continuity among critical building systems, and can be incorporated into an existing data center space or can be defined and operated as a separate entity (see Figure 4). Information security is still a primary concern, and for this reason the connected building data center must be located in a secure environment which minimizes the chances of security breaches or system downtime. A UPI-based solution enables tangible improvements in infrastructure efficiency, assuring the integrity and functionality of the connected building data center space.



**Figure 4. Examples of a Connected Building Data Center**

*At left: CBDC Integrated into Larger Data Center Architecture*

*At right: Smaller, Standalone CBDC Deployment*

## Financial Analysis

The culmination of the connected building planning process is the financial analysis of the project. This phase of the process focuses on evaluating the ways that UPI principles can be applied to achieve higher asset utilization and an improved cost structure for the connected building investment.

Although budgets are finalized at the end of the planning process, the financial impact of building decisions should be discussed throughout the entire process (i.e., internal/external alignment, technology strategies, network design considerations). Tables 1 and 2 illustrate the core capital and operational cost efficiencies that can be realized when executing a connected building strategy.

**Table 1. Connected Building Capital Expense (CapEx) Cost Efficiency Matrix**

### CapEx Savings

Goal	Benefit	Efficiency Gain*
Aggregate all low voltage and fiber optic cabling requirements	Enhanced reliability, building system efficiency, convergence	Reduce cabling cost by up to 10% by converging networks at design phase to reduce number of networks, cables, and associated contractors
	Reduced materials cost (less connectivity, baskets, conduit, etc.)	
	Fewer siloed systems to install	
	Eliminate multiple levels of (sub)contractor markup / reduced supervision requirements	
	Increased pricing leverage / simplified contract management	
Use PoE to reduce need for higher voltage power installation	Reduce installation cost by eliminating additional AC outlets	Reduce outlet requirements by up to 25%
Use zone enclosures to reduce control systems footprint	Optimize connected building real estate	Reduce required space by up to 67%

\* Estimates based on Panduit World Headquarters business case; other results may vary based upon user data.

**Table 2. Connected Building Operational Expense (OpEx) Cost Efficiency Matrix**

**OpEx Savings**

Goal	Benefit	Efficiency Gain*
Manage energy use	Networked lighting controls, energy system sub-metering optimize energy consumption	Achieve energy savings up to 25%
	Continuous commissioning and optimized performance configuration for HVAC	
	Support sustainability initiatives	
Reduce maintenance costs	Intelligent fault detection extends life of systems	Achieve maintenance savings up to 10%
	Real-time information sharing improves systems diagnostics and reporting	
Optimize staffing	Fewer expert technicians required to operate/maintain open (i.e. non-proprietary) systems	Increase staff productivity up to 25-30%
	Centralized/remote management enables efficient oversight of multiple properties by same staff	
Enable future reconfigurations	New applications utilize converged network backbone	Reduce reconfiguration costs up to 20%
	Less abandoned cabling to remove	
	Zone enclosures improve ease of patching / reconfiguration	

\* Estimates based on Panduit World Headquarters business case; other results may vary based upon user data.

## Conclusion

Executing a successful connected building strategy requires a coordinated strategic approach across four functional phases: organizational alignment, technology strategies, network design considerations, and financial analysis. This approach allows owners and developers to leverage connected building infrastructures as a true business asset to achieve security, sustainability, operational efficiency goals.

A properly designed UPI-based intelligent infrastructure lowers the overall connected building procurement and management cost structure, helping stakeholders meet budget requirements and maximize property value. Under this strategy all building systems become part of the converged physical and logical network, which will be flexible and scalable to meet future requirements.

By optimizing the planning process at each phase, building stakeholders can realize the following proven benefits of a UPI-based connected building solution to enhance real estate value:

- A clear technology strategy that supports sustainability, interoperability and converged networking goals.
- A current-day network design strategy that includes a Connected Building Data Center (CBDC), middleware, and a converged physical and logical network.
- Financial analyses that maximize capital and operational cost efficiencies, achieving higher asset utilization within an improved cost structure.
- Improved quality of service and enhanced occupant comfort and productivity.

## About *PANDUIT*

*PANDUIT* is a world-class developer and provider of leading-edge solutions that help customers optimize the physical infrastructure through simplification, increased agility and operational efficiency. *PANDUIT*'s Unified Physical Infrastructure (UPI) based solutions give Enterprises the capabilities to connect, manage and automate communications, computing, power, control and security systems for a smarter, unified business foundation. *PANDUIT* provides flexible, end-to-end solutions tailored by application and industry to drive performance, operational and financial advantages. *PANDUIT*'s global manufacturing, logistics, and e-commerce capabilities along with a global network of distribution partners help customers reduce supply chain risk. Strong technology relationships with industry leading systems vendors and an engaged partner ecosystem of consultants, integrators and contractors together with its global staff and unmatched service and support make *PANDUIT* a valuable and trusted partner.

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