

# Improving Performance with Integrated Smart Buildings

Executive Summary: Smart buildings exist today. They are increasingly valuable for both facility executives and the overall organization. Smart building strategies can reduce energy costs, increase the productivity of the facility staff, improve building operations, support sustainability efforts and enhance decision making across the organization.

The key to a smart building is integration: linking building systems together and then connecting the building automation system to enterprise systems. Integration is enabling facility executives to reap smart-building benefits, both in new construction and also by gradually transforming existing buildings into smart buildings.

Many buildings currently have the capability to become smart buildings. But facility executives often fail to take advantage of those capabilities, not realizing that the advanced technology in their building systems is a platform for a smart building.

This white paper takes an in-depth look at smart building capabilities being implemented today, and shows facility executives options they can consider to make their own buildings smarter.

## The white paper examines:

- What makes a smart building
- Smart-building strategies being used by specific buildings
- Benefits of integration
- How existing buildings are using integration to become smarter
- Challenges to creating smart buildings

building  
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White paper

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To some facility executives, the term “smart building” may conjure up images of a building of the future from a science-fiction movie. But the reality is smart buildings exist today, and their number is growing. There are smart office buildings, smart health care facilities, smart hospitality complexes, smart educational facilities and many other types of smart buildings.

What these smart buildings have in common is integration. By using sophisticated building automation systems (BAS) to integrate individual building systems, facility executives can take full advantage of the power available in today’s building systems. Seamless integration based on building automation systems brings a range of benefits to both the facility executive and the larger organization, all the way up to the C-suite. These benefits range from energy savings to productivity gains to sustainability. And once building systems have been integrated, the building automation system can be tied to enterprise business systems to add another level of intelligence to enhance decision-making and improve building performance.

### Attributes of Smart Buildings

Smart buildings depend on intelligent building automation systems to seamlessly integrate and manage a facility’s core systems, such as HVAC and lighting, among others. But there is no single set of capabilities that defines all smart buildings. Rather, the smart building concept is a dynamic process that enables an organization to use integration to tap the power of systems that are in a building today, while also providing a path to future improvements.

A good example of a smart building in action is the Duke Energy Center, a LEED Platinum 48-story office tower located in uptown Charlotte, N.C. Owned by Wells Fargo & Co., the Duke Energy Center was chosen in 2010 as a grand prize winner of the inaugural Siemens Smartest Building in America Challenge.

In the Duke Energy Center, 16 separate building systems, including three building automation systems, are integrated through one routed Internet Protocol network. The 1.5 million-square-foot office building also has a Tier IV data center. The complex building automation system was customized to accommodate multiple protocols (BACnet, OPC, LonWorks, Modbus and PLC) to allow for efficient system operation and data collection from diverse building systems.

Integrated systems in the center include lighting controls inside and outside of the building, light harvesting blinds, seven

**“If properly set up, a smart building can be operated and maintained at a very high standard that can then be used ... to get or retain tenants,” says Craig Cherry, Oklahoma DCS, Facilities Management Division**

## Steps to Smarter Buildings

There is no single definition of a smart building — no litmus test that says one building is “smart” while another one isn’t. Instead, a set of smart building capabilities provides facility executives many ways to make their facilities smarter. Every facility is different, and so are the smart building characteristics that are most appropriate for that facility. Here are some of the smart building approaches described in this white paper.

- The building automation system at Providence St. Peter Hospital enables a range of smart building actions, including set-back of air handling units in unoccupied operating rooms, a three-pass heat recovery system and optimizing supply fan discharge temperatures.
- MGM Resorts International uses load-shedding programs to keep from operating during peak demand times. For example, one program starts lowering chilled water temperature hours before heat arrives.
- Many facilities have modern building automation systems that offer a range of smart building capabilities, including data monitoring, energy-saving programs like optimal start/stop, and electrical load-shedding for demand-limiting conditions.
- A smart building automation system allows the smoke evacuation equipment at the Los Angeles Convention Center to take care of conditioned space during normal operation, while switching to smoke evacuation mode if necessary.
- At the Duke Energy Center, integrated systems include HVAC, lighting and daylighting, power reliability, security, emergency preparedness, metering, and water management.
- For emergency preparedness, one regional health care provider monitors critical building systems on the main IT network.
- Smart building integration often links HVAC, lighting and metering systems. Higher level applications may pull in elevators, access control and fire alarms.
- Brandywine Realty Trust has upgraded systems from analog to digital, and from dial-up to Web-based connections.
- Educational facilities are integrating building automation systems with fire and life safety and mass notification systems to improve security during an emergency.
- The City of San Francisco Public Utility Commission headquarters integrates 23 systems, bringing every point to the enterprise level, with 460 dashboards providing data.

2.25-megawatt generators and several uninterruptible power supply systems. The center also integrates elevator monitoring, video surveillance from 200 security cameras, emergency intercom systems, digital signage, parking access and revenue control (PARC) system — even a custom underground water filtration system. System integration on utility meters extends down to sub-submeters that can capture energy use from plug load, HVAC and lighting on a floor-by-floor basis.

Jim Patterson, regional property manager for Childress Klein Properties, who manages the building, estimates there are between 20,000 and 30,000 individual points managed and controlled through the same Internet Protocol network.

The City of San Francisco Public Utility Commission headquarters is another example of a new smart building. “Every data point is being brought to the enterprise level,” says Jim Sinopoli, managing principal of Smart Buildings, a professional engineering and design firm. In all, 23 separate building systems are integrated and 460 dashboards provide data to those who require the information.

But a building doesn’t need hundreds of dashboards or thousands of points of control to qualify as a smart building. In fact, any building that uses integration to connect building systems to improve efficiency, control and decision making qualifies as a smart building.

#### **Integration Is the Foundation of a Smart Building**

Smart-building integration begins by linking such core building systems as lighting, power meters, water meters, pumps, heating and chiller plants with sensors and control systems. At a higher level, elevators and access control systems enter the picture, along with shading and more advanced concepts. Integration can also encompass the fire alarm system to further improve safety.

“In this scenario, the BAS can request the fire automation system to open or close certain fire/smoke dampers to isolate floors for after-hours air conditioning,” says Garry Myers, vice president/director building automation services for WSP Flack + Kurtz, a mechanical and electrical engineering firm. “This may take place as long as the fire automation system has ultimate control in the event of a fire alarm.”

At the Los Angeles Convention Center, the smart building automation system allows the smoke evacuation equipment to wear two hats. “During normal operations, the system takes

**“(A smart building) is still a cost premium. But by spending upfront, it’s possible to reduce costs dramatically,” says Robert Knight of Environmental Systems Design.**

## **Smart Buildings Are Dynamic**

Becoming a smart building is not a one-time event. Facility executives who take a long-term perspective can incorporate smart-building improvements over time.

For example, over the years Brandywine Realty Trust has upgraded systems from analog to digital, and from dial-up to Web-based connections. The transformation is not overly complicated, but it is time consuming, says Brad Molotsky, executive vice president and general counsel for the REIT. “Now, as part of our specifications, all systems we have must be upgradeable to digital and Web-based and all systems must be open-protocol, loop-net type architecture,” he says.

Because it is dynamic, a smart building can gain new capabilities to meet organizational needs. In other words, even smart buildings can learn new things. Currently, the Los Angeles Convention Center is retrofitting old-style pneumatic damper actuators to modern air handling units with variable frequency drives. “Wear and tear is minimized because we are not starting and stopping them constantly,” says Rey Castro, chief building operating engineer for the center.

At Duke Energy Center, Wells Fargo and Childress Klein are working toward fault detection, diagnostics and continual commissioning. And at Providence St. Peter Hospital, the operations staff found more uses and applications for the building automation system as time went on. Eventually, the hospital qualified for the Energy Star label, which it has received seven times since the application of its smart building system.



The Los Angeles Convention Center is enhancing its smart building capabilities with upgrades to its ventilation system.

care of conditioned space, adding required outdoor air as needed," says Rey Castro, chief building operating engineer for the Los Angeles Convention Center. "Should an area incur smoke or a detector activates, the system returns to smoke evacuation mode."

It's easy to see how integration can bring gains. Consider a high security building that requires tenants to use a swipe card or key fob to gain building access, says Brad Molotsky, executive vice president and general counsel for Brandywine Realty Trust, a leading REIT. On some days, the tenants may only have 50 percent of their staff in the office. That information can be relayed to the HVAC system through the building automation system so the outside air dampers do not bring in unnecessary outside air.

Another benefit comes on days when there are multiple unoccupied offices in an HVAC zone. In this case, the smart building management system could ease temperature requirements in that zone and keeps the lights off in those offices. "Having the lights, HVAC, carbon dioxide sensors and security all speaking with and to each other can make a big difference, with coordinated communication being the key," says Molotsky.

#### Integration Can Reduce Peak Demand

Smart building capabilities help facility managers control energy costs. MGM Resorts International has acquired numerous hotels with various types of building automation systems. What all properties have in common is the need to manage energy. "When you pay in excess of \$1 million monthly for energy, even 5 percent savings is a huge amount of money," says John Leslie, manager of energy and building automation.

Leslie's smart building management system at The Mirage in Las Vegas uses load-shedding programs to keep from operating during peak demand times. "We have very high peak demand charges," Leslie says. "The highest rate can occur between 1 p.m. to 7 p.m. If we can reduce energy usage and keep equipment from starting during that time, it can mean hundreds of thousands of dollars saved."

The Mirage's smart building attributes include a chilled water program that constantly measures set points, heat loads and demand. Several weather stations monitor wind, weather, humidity and sunrise/sunset data. If a really hot day (110 degrees Fahrenheit) is predicted, Leslie uses a program that starts lowering chilled water temperature hours before the

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In the Duke Energy Center in Charlotte, N.C., 16 separate building systems, including three building automation systems, are integrated on one network.

## Understanding the CIO's Perspective

IT departments are an essential part of planning for a smart building. Smart buildings leverage advanced technology and IT to become smart, efficient and sustainable. Smart building management systems can be integrated across the organization's IT network, provided the network is robust enough to handle the additional data without compromising other crucial functions.

"Some smart building management systems do operate on our main network and some don't," says the CIO of a regional health care organization. "It's more a matter of convenience than a centralized strategy." He says that his organization prefers to keep most IT functions and smart building functions operating separately under normal conditions. Like many CIOs, he is concerned about broad business issues — in his case, patient care and business services — rather than details of building systems integration. Those are in the hands of the facility executive.

That's not to say that building systems — and the information they generate — don't have a major business impact. They do, and a growing number of savvy executives understand that. For the health care CIO, a good example is emergency preparedness. "From a disaster planning perspective, IT and facilities people have to be monitoring and thinking about building systems together," he says. At his organization, critical building systems for disaster planning can be monitored on the main network.

heat arrives. "Sometimes the system starts lowering the chilled water temperature at 3 a.m. if trending shows we're in for a really hot day," says Leslie.

#### **Productivity Improvement, Tenant Retention**

One major advantage of a smart building is that it improves productivity. At the Los Angeles Convention Center, the workload associated with building operations is significantly reduced with today's integrated technology, compared to 20 or 30 years ago. "Back then, we had a stack of work orders," says Castro. "We would have to walk to each location and figure out what they wanted and what parameters needed to change to achieve that. It took a little army to do all this work."

Operating the convention center's building management system in trouble-shooting mode saves time and allows building operators to fix glitches rapidly. "Half the time the problem is that a device got overridden or a command didn't go through," says Castro.

What's more, a smart building functions better. "When you get fully integrated with a single platform for building operating functions, the biggest benefit is operators are more aware of what's happening in the building," says Robert Knight, senior associate with Environmental Systems Design, an engineering design firm. "Mistakes get fixed faster. The facilities staff can be more responsive to tenant comfort."

Another benefit, says Myers of WSP Flack + Kurtz, is that maintenance shutdowns can be planned rather than risking "unexpected disastrous failures." The building automation system can use accumulated run times of equipment to initiate work orders for regular service and maintenance operations.

As a result, a smart building can be a significant asset in leasing efforts. "If set up properly, a smart building can be operated and maintained at a very high standard that can then be used as a selling point by the owner when trying to get or retain tenants," says Craig Cherry, facilities operations manager for the State of Oklahoma DCS/Facilities Management Division. "A properly designed and implemented building management system will be the best tool a building manager or operator can have at their disposal."

#### **Reduced Costs, Security Gains**

In new construction, a smart building can cut some capital costs. Sinopoli of Smart Buildings points out that standalone building systems need equipment rooms and cabling, as well

**Smart buildings "are more effective to operate, cheaper to operate and offer so much potential for future efficiencies," says Jim Patterson, Childress Klein Properties.**

## **Existing Buildings Can Also Be Smart Buildings**

A building doesn't have to be new to be smart. Facility executives can use a step-by-step process to incorporate smart building capabilities into existing buildings.

#### **Providence St. Peter Hospital**

Providence St. Peter Hospital in Olympia, Wash., was a grand prize winner in the Siemens 2011 Smartest Building in America Challenge. The hospital serves a five-county area and has been in continuous operation since 1887. Its mission is to offer health care to the area's poor at little or no cost.

Providence St. Peter Hospital realized that, to provide a comfortable environment for patients and staff while remaining fiscally responsible, the organization needed a smart building. So, in 2001, Providence began a huge project to upgrade legacy equipment and controls. After that upgrade, facility operations staff began adopting new strategies that the older controls were not capable of performing.

For example, because all thermostats served by an air handling unit are now monitored, the supply fan discharge temperatures can be optimized to maintain occupant comfort with the least energy consumption. Occupancy sensors enable the surgical air handling units to be set back when operating rooms are not in use. A sophisticated building automation system program controls a three pass heat recovery system for boilers; boiler feed water, space heating water and domestic hot water are all heated using waste heat from the boilers. Because it uses adaptive control, the building automation system also provides a higher level of control of HVAC system pressures and temperatures than was possible with standard PID loop tuning.

Since the upgrade, Providence St. Peter Hospital has seen lower electricity and natural gas bills.

#### **Microsoft**

Jim Sinopoli, managing principal of Smart Buildings, cites Microsoft as another example of an organization that is taking steps to make its existing buildings smarter. Microsoft is rolling out a smart buildings effort that includes, in its initial phase, fault detection and diagnostics, which will identify problems, rank them in order of priority and estimate the cost of wasted energy.

The benefit of fault detection is that it can find hidden problems. For example, it identified a valve that was always 20 percent open, costing the company thousands of dollars in wasted energy. Microsoft's smart buildings effort also includes tools to help facility staff manage and make sense of the hundreds of alarms they receive every day, as well as an energy management component that will help optimize building base load and power consumption by, among other things, providing analytics to tune set points and schedules.

as cabling pathways. “With smart building concepts, you can reduce the cable and pathways by coordinating infrastructure,” Sinopoli says.

Savings can also come when the fire alarm system is integrated with the building automation system. This results in a design cost savings because the building can use the fire/smoke dampers rather than installing separate automatic louver dampers. That also reduces wiring and points in the building automation system.

Integration can also be used to enhance safety and security. “Educational facilities are increasingly integrating their building automation system with their fire and life safety system in an effort to enhance security during an emergency,” says Alejandra Lozano, environmental and building technologies research analyst for Frost & Sullivan. “For example, a building automation system can be used to lock doors to a specific area and can be integrated with the mass notification system to provide critical information to the people located in the affected area.”

### Building Automation Capabilities

Many organizations are closer to having smart buildings than they may realize. That’s because existing building automation systems may well have capabilities that are the foundation of an integrated smart building.

A modern building automation system pulls in data ranging from temperature and humidity readings to motor statuses, says Myers of WSP Flack + Kurtz. The building automation system often includes energy optimization capabilities. For example, with optimal start/stop, the building automation system learns when it must bring the air conditioning system on line for a particular zone in the building.

Another standard feature of the building automation system is electrical load shedding for demand-limiting conditions. In this situation, electrical loads are grouped into categories from critical to high priority to non-essential. “When the building load is rising and approaching the high limit setting, the non-essential loads are turned off in their sub-group order, followed by the high priority loads,” says Myers.

The smart building approach has the potential to take the building automation system to a whole new level, using open protocols, standardized databases and middleware that can take data points and normalize them to a common database, says Sinopoli. Then dashboards are prepared for different groups. Eventually, the concept stretches from one integrated building to a campus and then to an enterprise.

**It’s important to “get IT to the table early” when the smart building is in the conceptual stage, says Jim Sinopoli of Smart Buildings.**



At Three Logan Square in Philadelphia, HVAC operations — including chillers, fan systems and heat from the district steam loop — are integrated through the energy management system to enable Brandywine Realty Trust to optimize performance of the building.

### Overcoming Challenges

Experience has shown there can be challenges to creating a smart building, but experience also shows those challenges can be overcome.

For example, IT departments are sometimes hesitant to allow the building automation system to run on the corporate network, even though a properly designed and integrated building system will not compromise an IT network. One way to allay IT concerns is to bring the building automation system vendor into meetings with the CIO to answer specific IT questions.

To avoid problems, Sinopoli says, it’s important to “get IT at the table early” in the conceptual stage. “Eventually, you will need servers, network connections and cloud access, and chances are those servers are going to sit in IT’s data center,” he says.

Another challenge is ensuring that smart building capabilities match up with the needs of the facility. “The most successful smart buildings I have seen and been associated with had the proper application of current technologies that matched up well with the owner’s idea for the operation of the facility,” says Cherry from the State of Oklahoma. “This requires a great deal of communication during the design stage to make sure all parts of the facility are considered.”

Cost can also be a challenge. A smart building often means investing upfront money for life-cycle savings. “It’s still a cost premium,” says Knight of Environmental Systems Design. “But by spending upfront it’s possible to lower life-cycle costs dramatically.” Knight sees three ways that smart buildings can bring life-cycle cost benefits: sub-system paybacks, synergies and soft benefits.

“The calculation of life-cycle costing of the simple sub-systems is well understood,” Knight says. For example, “efficient lighting controls and efficient HVAC both contribute their life cycle benefits to the total smart building.”

Synergies include effects that are apparent and realized from Day 1, as well as benefits that become apparent over time. One example of a synergy is sharing lighting control occupancy sensor data with HVAC to allow greater HVAC efficiency at relatively low cost. Another example: Steps to reduce electric consumption and flatten peaks position the building to realize savings from future “smart grid” electricity contracts. Gains from synergies are harder to project than savings from sub-systems.

Soft benefits, such as higher occupancy rates or lease prices, healthier occupants with higher productivity, or marketing cachet, are difficult to quantify and can shift by orders of magnitude based on the assumptions and stipulations made. Castro says that convincing management to keep improving his smart convention center isn’t always easy. “If you can show them how to save operating costs, then you have their attention,” he says.

Facility executives should be willing to consider creative financing options. For instance, an energy audit from the municipal utility identified old chillers as a problem at the Los Angeles Convention Center. “We asked for an energy loan to do what they recommended,” Castro says. The convention center also received a rebate for the new chillers. Between savings and rebates, the loan was paid back in 1.5 years.

As important as hardware and software are, says Cherry, the people operating the building make all the difference. “If the operator of a facility is not properly trained on the BAS, HVAC, tenant requirements and the desired outcome of the facility operations, then you will never have a smart building,” he says. “The BAS can be set up to operate efficiently and control all components in a facility. However, over time there will be failures in equipment, changes in tenant needs, along with many other factors that require a person properly trained on all aspects of the smart building.”

People issues aren’t limited to system operators. Often, several different vendors provide building systems. “Just because a vendor can meet an equipment specification it does not mean the technician setting up the equipment can make it work as designed,” Cherry says. Carefully crafting the equipment specifications can weed out vendors that technically

**“Having the lights, HVAC, carbon dioxide sensors and security all speaking with and to each other can make a big difference,” says Brad Molotsky, Brandywine Realty Trust.**



**At The Mirage in Las Vegas, the smart building automation system uses a load-shedding program to keep from operating during peak demand times.**

“meet the spec” but then cannot produce the expected results from the installed system.

### Open Protocols Can Open the Door to Smart Buildings

Incompatible protocols can be a significant challenge, but today that need not be a concern. “With open protocols such as BACnet and its continuous updating, this is becoming less of an issue,” says Myers of WSP Flack + Kurtz.

As much as possible, Knight sees integrated automation systems needing open protocols “on every layer, so that when problems occur, everything from a valve to a computer can be taken apart and turn-keyed. Every link needs to be open and able to communicate with other third-party software.” Major communication protocols used in building controls have certification processes that ensure interoperability. For example, the BTL Mark from BACnet Testing Laboratories certifies that devices with the mark correctly implement the BACnet features claimed in the BTL listing. And LonMark International offers certification that products using LonWorks technology are developed using LonMark functional profiles. Facility executives should look for certified devices.

### Conclusion

Smart buildings are increasingly valuable for both facility executives and the overall organization. Smart buildings improve the productivity of people and processes and help organizations make better decisions. Integration is enabling facility executives to reap smart-building benefits, both in new construction and also to gradually transform existing buildings into smart buildings.

Smart buildings are “the wave of the future, particularly for large buildings like the Duke Energy Center,” says Patterson, who manages the Duke Energy Center for Childress Klein Properties. “From a building operating point of view, they are more effective to operate, cheaper to operate and offer so much upside potential for future efficiencies that we haven’t even thought of yet.” ■

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