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Smart Building Automation and the Enterprise Internet of Things

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Executive Summary

While the smart home has generated intense consumer interest, the connected warehouse, factory, office, bank, and storefront may hold the most potential for adoption and innovation in coming years. Unlike residential properties, commercial properties have long-standing operational management histories with operations personnel and efficiency programs that have long been awaiting cost-effective and controls-driven systems. While operational efficiencies from lighting, heating, and cooling will provide early returns and speed adoption, the control-enabled buildings they create will become platforms for entirely new interactions. These smart buildings will allow businesses to control new hardware and create new contexts and safer, more-lucrative, and more-automated experiences for their occupants, employees, and customers.

Collaboration is critical for the Internet of Things (IoT) to become more than just a sensationalized concept. Companies, emulating their customers, are now actively engaging in a collaborative economy that threatens to squeeze out corporate middlemen. Enterprise business must react more nimbly to market shifts than large businesses have long done and adopt open standards, which replace proprietary interfaces and protocols that have otherwise been holding back the market for IoT-enabling devices and features.

Advances in embedded technologies are enabling a rapid growth in the number of smart, machine-addressable devices delivered to market. These smart devices usher in the Enterprise Internet of Things (E-IoT) by incorporating machine-to-machine (M2M) wireless communications that promise to change the landscape of enterprise smart building automation. Through careful execution, E-IoT capabilities enable the critical real-time control, measurement, and monitoring necessary for improved planning, timing, efficiency, and effectiveness of sustainable business operations.

Key findings in this report include:

- E-IoT helps generate very real and ongoing cost savings for businesses managing physical facilities.
- Smart building wireless control solutions for lighting, HVAC, plug loads, and other devices in a building are the core for E-IoT. Lighting retrofit projects provide the impetus for companies to roll out these types of solutions.
- If they want the highest prospect of savings, businesses must extend connections beyond large devices to less obvious devices.

- Open standards are essential for seamless operation and future-proofing technology choices.
- IT and facility operations play equal roles in a successful E-IoT deployment.

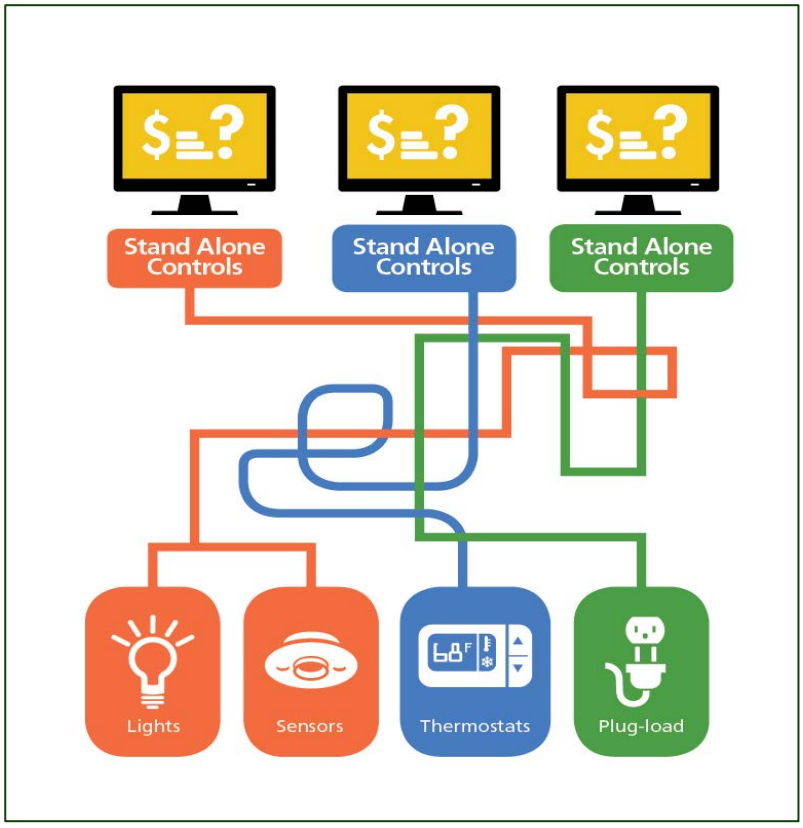
The Case for Building Automation and Control Systems

The potential value of building-based energy savings is remarkable. Roughly 40 percent of all energy consumed in the United States powers the country's buildings, with total energy usage split fairly evenly between residential and commercial buildings at 22 percent and 18 percent, respectively. The investment opportunity for building energy-efficiency retrofits has been valued at nearly $300 billion, while the energy savings opportunities could deliver a return on the order of $1 trillion over 10 years. To put that into perspective, the gross domestic product (GDP) for the entire U.S. economy is about $17.5 trillion.

The responsibility for capturing energy and cost savings opportunities in commercial buildings has been placed largely on the shoulders of facility operations personnel, motivating demand for enabling technologies to deliver building automation which make up building automation and control systems (BACS). While the economic benefits of deploying a BACS may at first seem obvious, technical and economic barriers to adoption and implementation have long limited its effective deployment and reach in commercial applications. With the emergence of connected, communicating devices and enterprise management software that together form an E-IoT, barriers to BACS deployment are rapidly falling away and new doors are opening to enable operational improvements in commercial buildings through the convergence of operations and information technology (OT/IT).

The ability to monitor and manage the performance and resource consumption of connected devices across the enterprise has long been a goal of operations personnel. Yet, the realization of such capabilities has been severely limited by the inability to justify the large capital investments required for centrally controlled management systems. Building automation implementations are typically available in only one of two types (Figure 1):

- First-generation building automation has been based on standalone applications (i.e. separate lighting control and HVAC control) that utilize hard-wired networks embedded in walls that required costly, labor-intensive installations and system integration.

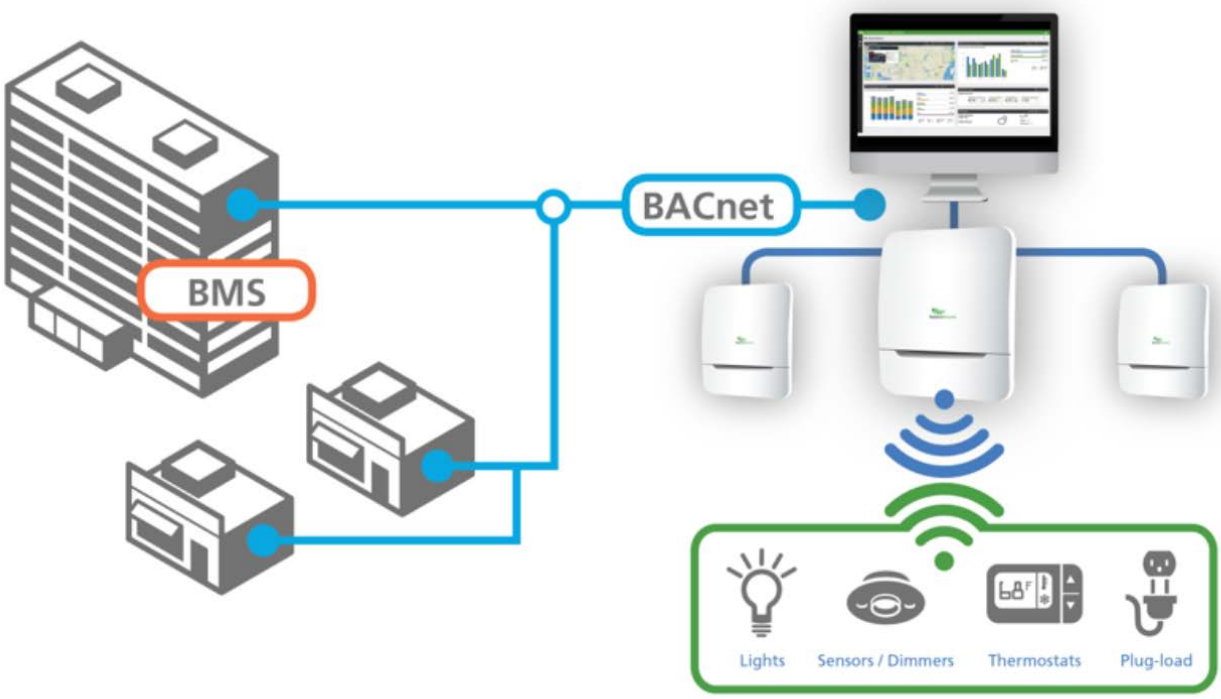


Source: Gigaom Research, Manifest Mind and Current, by GE

- Next-generation systems (BACS) utilized networked wireless sensors and repeaters to enable device communication and control of multiple applications in a single software system.

In both cases, building information is collected, aggregated, and delivered to a central location where operations personnel monitor and utilize it to the extent they're able. Further, the inherent cost of installing and maintaining legacy building automation has limited the number and types of connected devices to the largest, most resource-intensive building equipment. If legacy BMS is to achieve deeper savings and capture a significant business value, it must be extended beyond managing large equipment to connecting and managing devices and operational information across the enterprise. Unlike legacy BMS, next generation networked wireless control systems that are based on open standards offer the ability to scale and connect thousands of sensors covering multiple applications across several facilities.

Device Communication and Control



Source: Gigaom Research, Manifest Mind and Current, by GE

The Hype about Home Automation

Media coverage of smart buildings tends to focus on the future of smart homes , rather than on smart commercial buildings. The fixation on home automation technologies is more a reflection of popular culture than a consideration of technical or economic feasibility. While smart commercial buildings may not hold the same allure for popular media, their near-term outlook for energy and operational savings and related societal benefits is significantly brighter than that of smart homes.

Smart homes are an exciting prospect, but currently lack the economic driver for widespread uptake in the market, and in many cases, the end-to-end IT support necessary to realize its full potential. While this

is changing, the ability to support a compelling business case for the use of IoT to realize operational and energy savings without any major technological advancements or economic shifts is here today.

This doesn't mean that the smart home won't eventually arrive and thrive, but that enterprise solutions will get here sooner since they don't face nearly same types of commercialization barriers to entry that home automation solutions do. The cost of operating the average home—or small business—is minuscule compared to the operational costs and scale of energy consumption associated with enterprise facilities. For small businesses that only operate a small number of equipment in a handful of facilities and have modest annual utility expenditures, justifying investments in connected devices with either home automation-like or BCS capabilities can be difficult. Instead, the connected devices that comprise the IoT are expected to arrive first in the enterprise environment, and E-IoT is likely to make up the largest fraction of total IoT market value over the next few years.

Managing the Enterprise

On the industrial side of the market, networked sensors and the centralized monitoring and control of large, expensive equipment have been in place for decades. So is all of this talk about IoT just a new hype-fueled distraction? This assertion has been made in the past, but like any new buzzword, it's not always easy to separate media hype from meaningful progress. To answer those questions for the business market, understanding which devices will strategically position the modern enterprise to find competitive advantage from an unprecedented level of connectivity and potential efficiency is important.

IoT for the Enterprise

With rare exceptions, large businesses are at a greater risk of being downsized, shuttered, or acquired than ever before, and rapid technology advancement may be to blame. To stay in business and remain both relevant and competitive, large enterprises are increasingly forced to understand and operate within the evolving realities of the modern collaborative economy. Go-it-alone competitive strategies are no longer viable, now that the collaborative economy enables consumers to engage directly to meet their needs and avoid interacting with large corporations entirely.

Interoperability is the name of the game for a successful enterprise-level IoT deployment, and that requires the use of open standards for equipment and communications interfacing. Standards are a backstop against rapid technology-obsolescence. Technology interconnectedness is now just as important as inter-corporate collaborations and open-standards agreements, and intra-corporate relationships must be strengthened as information silos are removed to enable today's enterprise businesses to thrive.

Ending IT vs. OT Conflicts

Appropriately, the successful deployment of IoT technology advancements hinges on an effective merger of IT and OT capabilities within an organization. This merger first requires eliminating long-standing conflicts over priorities, budgets, and business resources. Other industries can look to enterprise data centers for an example of what they must do to dissolve historical lines of division between the function and management of IT and OT departments.

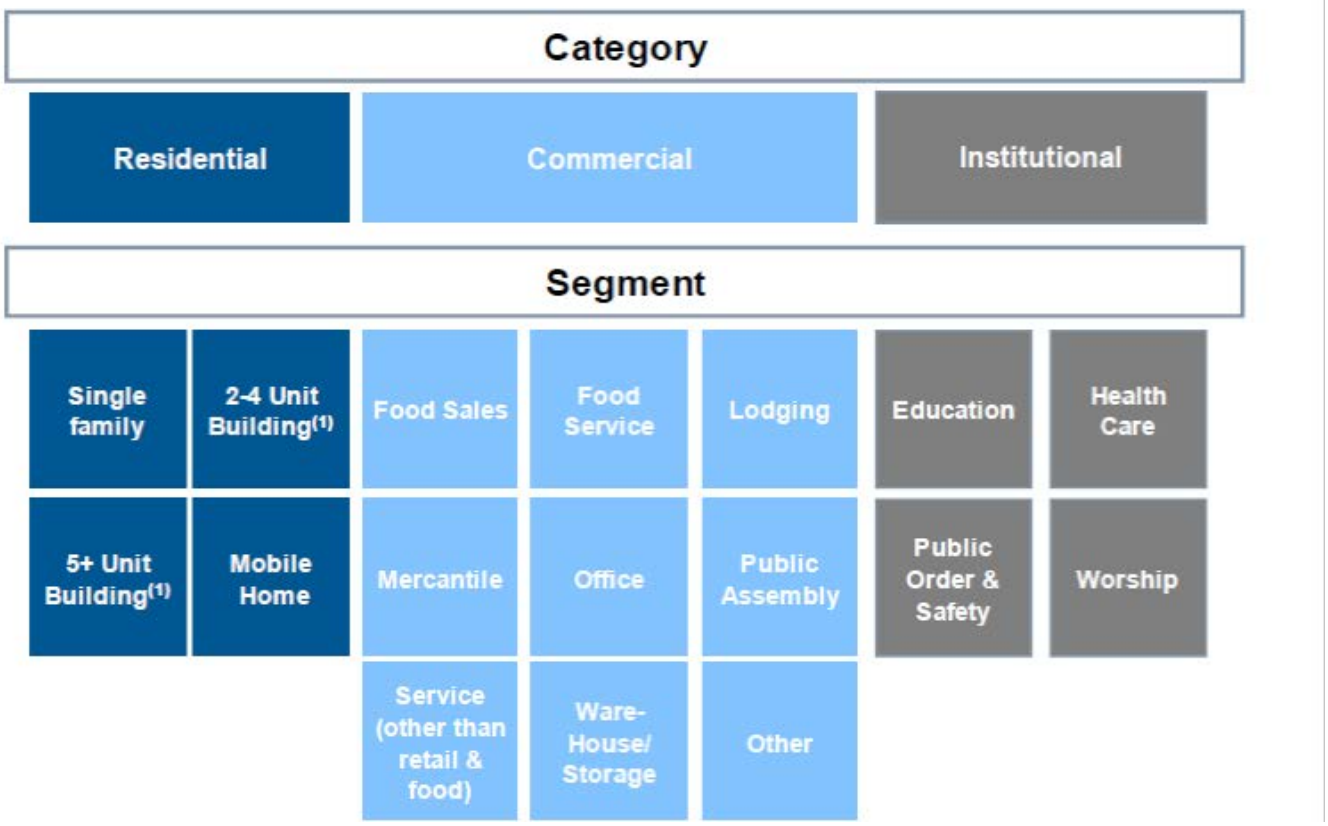
Neither IT nor OT can be favored in company decision making, and in many cases corporate restructuring may be a necessary step in aligning budgets and departments to coincide with high-level company priority and strategy. Internal squabbling over resource allocation can pose a bigger threat to enterprise longevity than industry competition. When IT and OT are aligned, barriers to innovation and productivity can effectively be dismantled.

Opportunities by Market Segment

Commercial enterprise represents a favorable market sector for early-market IoT roll outs, with preexisting supply chains and support structures already in place for deployment of the necessary technologies and services, as well as favorable resource end-use applications that are consistent and predictable by market sector. Figure 2 provides a general overview of market segmentation by sector categories and segments (the commercial business market is depicted in light blue) and describes the

types of buildings in this sector. Unlike the residential or institutional market sectors, the needs and energy end-use applications are more homogenous for commercial buildings.

General Overview of Market Segmentation



Source: Gigaom Research and Manifest Mind

While IoT opportunities exist across all three market categories, relative benefits and deployment characteristics vary by segment. For example, upgrading from traditional high-intensity discharge (HID) lighting to high-efficiency networked light-emitting diode (LED) luminaires for high-bay lighting applications combined with a control solution is a promising retrofit opportunity for many warehouse facilities. In retail store-front environments, control of lighting and networked air-conditioning units with occupancy sensing represent a promising end-use application of networked solutions for cost and resource savings along with operational efficiencies. For either of these two applications, deploying the first smart-building control system helps to lower the barriers to deploying additional (interoperable)

devices and systems by making the necessary wireless communications network, devices, and deployment know-how available.

Doing Well while Doing Good

In commercial buildings, two systems that consume considerable resources and could benefit significantly from machine-to-machine (M2M) connectivity are lighting and heating, ventilation, and air conditioning (HVAC). Interconnecting lighting and HVAC equipment can deliver big benefits in the form of cost savings, resource conservation, predictive maintenance, comfort control, and healthy building performance—both to each other and to an enterprise communications network and data-management system. Demand response is becoming popular and several states offer incentives to curtail energy during hot summer months when HVAC usage is at the peak. Control solutions with built-in DR capability not only help in code compliance but bring in additional savings through load reduction and rebates.

While these are not the only building systems that can and should be connected, they are the most-universally present and interdependent systems where operational performance is impacted by changing environmental conditions (e.g. building occupancy, local weather). As a result, connected lighting and HVAC serve as good candidates for advancing E-IoT beyond theoretical expectations in ways that can immediately deliver value for enterprise business operations. Harvesting this low-hanging fruit will lower the bar for advanced IoT applications. In commercial buildings, which vary widely based on building stock, geography and use, HVAC energy use represents about one-third of total energy use while lighting energy use makes up about one-quarter of total usage.

Cost Savings Opportunities

The cost-savings potential for IoT deployments will vary by market segment, region, facility, occupancy, application, and energy pricing. Due to the large number of dynamic and sometimes confounding variables at play, choosing partners that have a proven track record and deep knowledge of the building-management technology is important. Such partners may include companies acting as building systems integrators, construction contractors, equipment installers, or cloud service providers.

A major factor that affects cost-savings potential is the resource end-use mix for a building or fleet of buildings across the enterprise, as this can play a significant role in determining cost-effective applications and designing successful projects. For example, lighting in food retail facilities is commonly

the single largest energy end-use application, but in public assembly facilities lighting represents a relatively small percentage of overall energy usage while space conditioning dominates the mix.

Energy and Resource Savings

For hard-wired legacy BMS deployments, reports of 10 to 20 percent energy savings were not uncommon in the early years of deployment. While the baseline for building performance has ratcheted steadily upwards over the last 15 years, so have improvements in technology. As a result, players operating in this space have consistently reported that it is possible to achieve at least 20 percent energy savings, as well as realize additional resource savings and NEBs, with the well-executed deployment of a modern BACS that utilizes networked devices.

Other Operational Benefits

In addition to cost-, energy-, and other resource-saving benefits, advances in IoT technology promise to deliver operational benefits that can help OT personnel work smarter and make critical decisions faster than ever before. When individual equipment is machine-addressable and capable of directly communicating with other devices upon which its operation is interdependent, problems can be detected and remedied while they are still small and easy to fix. OT departments can also benefits from gaining greater insight into departmental performance and the impact of changes to facilities operations.

Source: Gigaom Research and Current, by GE

Making the Case for Investment

When our use of the Internet was primarily focused on sharing information, connectivity across networks was essential to creating business value and to justify the need for investments to help extend the reach of online business. Bob Metcalfe, the "Father of Ethernet," is largely responsible for popularizing theories on the importance of connectivity to online business, yet the dot-com bubble burst of the early 2000s serves as a cautionary tale and reminder that connectivity alone is not sufficient to create and sustain business value. Even more important to the deployment of IoT than it was for the Internet, some connections are more critical than others – such as those between devices that must operate together to serve a particular function or service to the building. Beyond a certain threshold, the value of interconnecting additional devices will demonstrate a diminishing rate of return. Strategic device connectivity is key to successful IoT deployment for the enterprise.

Return on BACS Investments

Realizing a favorable return on investment (ROI) for BACS upgrades can be difficult when large, lump-sum capital investments are needed. A number of financing opportunities exist to help make building upgrades more financially palatable, but with the advent of wireless modular equipment, it's possible to employ a gradual phase-in of new devices as old equipment fails or to add digital capabilities to traditionally non-digital building equipment. With such an approach, it may even be possible to utilize operations and maintenance (O&M) budgets and avoid having to fight with other departments over limited pools of money available for new projects or large capital investments.

For efficiency retrofit projects in general, commercial lighting typically has the quickest rate of return on investment (e.g. 1–4 years) and thus represents an attractive option relative to other facilities upgrade projects. These ROI estimates don't account for non-energy benefits (NEBs) such as operational efficiencies, improved productivity and employee wellbeing that can also result from lighting or other facilities upgrades.

Strategic Advantage

Today, advances in embedded technologies are enabling a rapid growth in the number of smart, machine-addressable devices that can and are being delivered to market. These smart devices promise to usher in the E-IoT through M2M wireless communications and promise to change the landscape of enterprise building management. Advances in area network technologies and security are also helping to make smart building management more technically and economically feasible than ever before. Through careful execution, E-IoT capabilities help enable the critical real-time measurement and monitoring that are necessary to the improved planning, timing, efficiency, and effectiveness of sustainable business operations. Analytics tools used in conjunction with IoT devices and networks make possible advanced capabilities that can help OT personnel identify system performance anomalies, supply-chain errors, and system degradation issues before they result in wasteful and expensive business failures. Automation through M2M interfacing also helps to reduce opportunities for human error and free up personnel to engage in more-rewarding, value-added business activities.

The Long View: Sustainability

While most CEOs might not quite be ready to downsize their company's operations in the best interest of environmental and social sustainability, it's still possible to do the right thing and make good money while doing it. However, a challenge lies in adequately anticipating the pace of change and understanding

the implications of a continuously connected world on business operations and strategic decision-making. To meet these challenges, companies must openly embrace a long-term view that includes organizational change through internal and external restructuring, allowing them to adapt to the new dynamics of the collaborative economy as well as to the rapid pace of technological progress.

Key takeaways

- IoT's benefits to businesses managing facilities are real and more significant than the hype and buzz might suggest.
- Lighting is ubiquitous and with a dramatic momentum for LED retrofit projects across various sectors, it has become the key driver for driving smart building automation solutions and making it the Trojan horse for the Enterprise Internet of Things.
- The longevity of today's enterprise businesses hinges more than ever on their ability to adapt to a rapidly evolving social and technological landscape.
- Achieving the full benefits of BACS requires extending beyond the managing only the largest devices in the building.
- Wireless open standards and value-added services are critical pieces of the IoT puzzle.
- Alignment of a company's IT and Facility Operations priorities is essential to the successful deployment of E-IoT.
- Strategic device connectivity is key to successful IoT deployment for the enterprise.
- Operational benefits and higher productivity through advanced analytics will continue to add value well beyond energy savings.

About the authors

Carol Stimmel has 23 years in emerging technology markets including operating roles, research and analysis, and product design. Despite studying philosophy which twisted her in knots, she is a frequent speaker, authored Big Data Analytics Strategies for the Smart Grid, The Manager Pool, and is deep into a new book on Smart Cities. She holds several technology patents, including energy benchmarking and communications.

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