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Smart Offices: How Intelligent Building Solutions Are Changing the Occupant Experience

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1. INTRODUCTION

There is a great deal of discussion about how to define the intelligent building and what it means for the future of the commercial office. Navigant Research suggests that the emergence of networked sensors and controls, wireless communications, and intelligence at the edge enabled by cloud computing is transforming commercial facilities into intelligent buildings. This IT architecture overlaid on the traditional building automation framework is delivering a new set of benefits beyond what building owners or occupants have experienced in the past. In this Intel-sponsored white paper, Navigant Research outlines how the intelligent building is delivering unprecedented energy and cost savings alongside new levels of occupant comfort. Open, scalable, and secure intelligent building solutions are delivering significant business benefits and transforming workspaces into smart offices.

1.1 The Intelligent Building as a Platform and the Internet of Things

The intelligent building represents a transformation of the commercial office through IT-based innovation in building controls and automation that answers the demands of building owners, facility managers, and office workers. Building owners want to see stronger bottom lines, facility managers want fewer hot and cold calls, and occupants want access to information from and control of their work environment. The intelligent building meets all three of these core stakeholder demands.

Furthermore, the intelligent building helps owners differentiate their properties in a competitive market where tenants' shifting expectations are redefining best-in-class office space from luxury in appearance to green and intelligent. The IT backbone of intelligent building offerings is enabled by cost-effective devices that bring data from the edge to the cloud, all of which is made possible by the connectivity of the Internet of Things (IoT). Intelligent building software and energy management services provide unprecedented insight into facility operations, space utilization, and occupant satisfaction.

IoT-enabled cloud-based analytics is also valuable as a new approach to occupant engagement for improved satisfaction and better environmental conditions. As sensing devices are becoming more cost-effective and multifunctional, there is a movement to enhance the mobile applications of cloud-based analytics—tools that enable occupant interaction with heating, ventilating, and air conditioning (HVAC), lighting, and other building functions. IoT is open, secure, and scalable as a foundation. This infrastructure supports the smart office solutions that take occupant feedback and can deliver more customized settings, reflecting the specific preferences of occupants rather than modeled expectations.

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1.2 Tech Partnerships for Energy Savings and Happy Workers

In the following sections, Navigant Research presents the technology framework for the intelligent building, the state of the market, and snapshots on Intel partnerships with Building Robotics, Switch Automation, and KMC Controls. IoT infrastructure enables interoperable controls and automation across building systems, thereby delivering comprehensive benefits:

- Optimized maintenance practices that improve operational efficiency and support capital planning through better visibility into equipment conditions and potential for failure
- Occupant engagement that goes beyond the energy dashboard for comfort and satisfaction
- Energy efficiency improvements and greenhouse gas reductions that redefine the green building

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2. MARKET OVERVIEW

Open architecture, network security, and cloud-based analytics with mobile accessibility are the central tenets of the intelligent building. Section 2 outlines an Internet of Things (IoT) intelligent building platform that consists of a suite of components including intelligent gateways, open protocol communications, building energy management systems (BEMSs), and advanced controls. This redefined building design enables occupant engagement and delivers energy savings, operational efficiency, financial benefits, and worker satisfaction.

2.1 Introduction

IoT is an infrastructure for aggregating, transmitting, and analyzing data streams while ensuring cyber security and delivering domain-specific insights. It is a potentially disruptive market force because the framework unifies historically isolated data in order to generate comprehensive information about related systems. In the intelligent buildings context, IoT provides a structure to generate and share actionable insights for system improvement, which may take the form of fine-tuned lighting or heating, ventilating, and air conditioning (HVAC) settings. IoT platforms are scalable and secure to support software analytics that identify potential improvements for energy savings, operational efficiencies, and increased occupant satisfaction. These platforms give intelligent building decision makers more unified and comprehensive information about the performance of their individual facilities or portfolios.

In intelligent buildings, IoT encompasses multiple levels, including sensors, gateways, and network communications, as well as software applications to support energy management services for equipment and process optimization. The aggregation of data across historic silos and the resulting insights generated by IoT solutions can be more actionable because of the detailed and comprehensive insights, causing traditional solutions providers to compete against new alternatives to their offerings. In the buildings context, the result is an evolution in offerings from building automation incumbents, innovations from startups, and partnerships that leverage domain expertise and technology.

2.1.1 Benefits to the Building Owner

The IoT-supported intelligent building is changing how buildings are evaluated as financial assets in corporate holdings. For many years, energy management in facilities has been low on the priority lists of executive decision makers, who perceived energy costs as line items with little impact on the company's bottom line. In fact, according to the World Green Building Council,[1] 90% of typical building operating costs are associated with staff salaries and benefits. If energy and lease payments represent just 10% of the cost of doing business, why would customers care about intelligent building solutions? Navigant Research suggests that intelligent buildings indirectly lower worker costs. A growing number of intelligent building applications are designed to maximize worker efficiency and satisfaction by improving responsiveness to heating and cooling complaints, easing the process of finding collaboration space, fine-tuning lighting to meet specific worker preferences, and showcasing energy, waste, and water conservation improvements that support corporate social responsibility and sustainability commitments.

[1] World Green Building Council, *Health, Wellbeing & Productivity in Offices*, September 2014.

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These intelligent building solutions provide building owners with direct benefits in the form of cost savings due to energy efficiency and operational improvements. Building owners also receive indirect benefits in the form of happy tenants and high occupancy. More specifically, the optimized intelligent building maximizes tenant comfort and space utilization and improves productivity. The super-efficient intelligent building can also affect staff costs in various ways: staffing benefits in recruitment, productivity, and turnover and efficiency benefits in the form of energy savings and streamlined operations and maintenance.

2.1.2 Benefits to the Office Worker

The makeup of the future workforce is a hot topic in commercial real estate and facilities management. At present, the Millennial Generation makes up the largest share of the U.S. workforce.[2] Building owners are revisiting how they value their facility assets to align with this new generation's definition of comfort before Millennials become the leaders of America's businesses and sign the leases of tomorrow.

A recent study on the future of Millennial leadership[3] found that work/life balance, training, technology/ innovation, and pay equity are the four key issues prioritized by the next generation in the workplace. These statistics underscore the value of intelligent building solutions today. Such smart office solutions can give occupants access to data and a sense of control in parallel with their technology experiences outside of work. Examining the market from the supply side, another study looked at how commercial real estate is responding to the evolving workforce. This JLL survey[4] found that 76% of businesses expect their commercial real estate teams to enhance workplace productivity. Furthermore, the study indicates that over 80% of companies prioritize technology improvements, and 88% want to see improvements in space utilization. These two studies illustrate that when it comes to commercial buildings, both the vendors and customers in the facilities management industry can benefit from IoT-enabled technology advancements. The following sections outline the technology framework that can deliver the optimization to make offices smart and keep occupants happy.

2.2 BEMSs, the IT-Enabled Foundation

Software analytics is foundational to the intelligent building as the tool for translating ever increasing data streams into actionable insights. Navigant Research defines this segment of the intelligent building technology marketplace as BEMSs. This is an encompassing term for technology and service offerings that deliver business improvements, including cost savings and strategic capital planning, due to the more effective management of energy consumption and building operations. Navigant Research defines BEMSs as:

> *"IT-based solutions that extend the capabilities of sensing, control, and automation hardware to direct both automated and manual improvements to system operations."*

[2] Richard Fry, "Millennials Surpass Gen Xers as the Largest Generation in U.S. Labor Force," Pew Research Center, May 11, 2015.
[3] The Hartford, "The Future of Leadership by the Numbers," 2014.
[4] JLL, *Global Corporate Real Estate Trends 2015*, June 2015.

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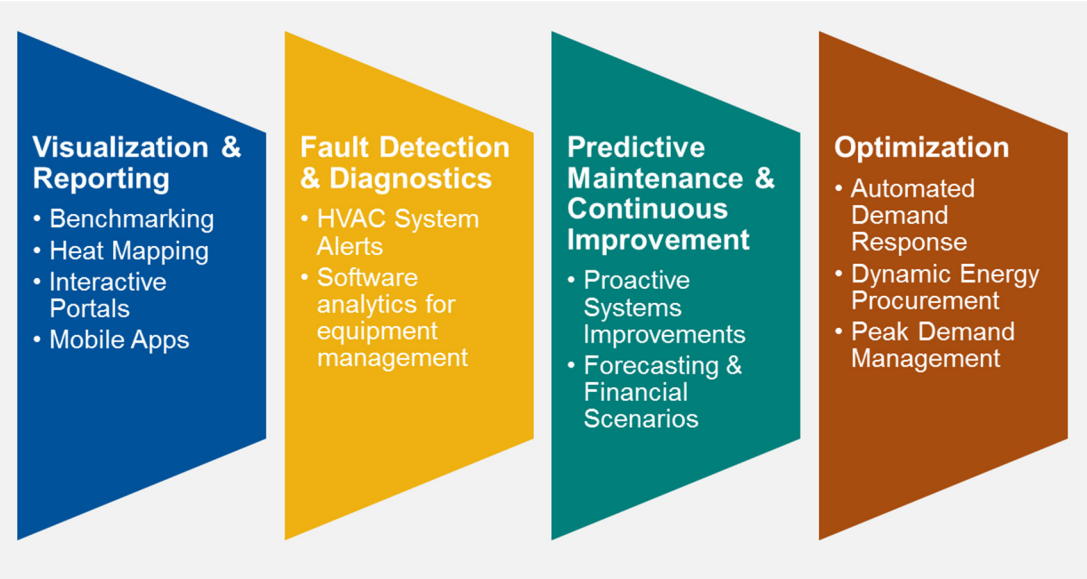
BEMS offerings deliver efficiency in two main ways: via focused improvements in HVAC, lighting, plug loads, or fire and security systems; and via the integrated management of multiple systems. A well-designed and implemented BEMS provides energy, cost, and maintenance savings while supporting strategic corporate objectives such as sustainability or climate-related goals. In other words, BEMSs can change the energy management paradigm to deliver strategic and holistic management of facilities and equipment.

BEMS solutions can enhance customer energy management capabilities with offerings in four classes, as illustrated in Figure 1. The mix of functions in a particular solution reflects the customer needs from a market maturity and facility infrastructure standpoint.

Figure 1 BEMS Offering Classes and Applications



(Source: Navigant Research)

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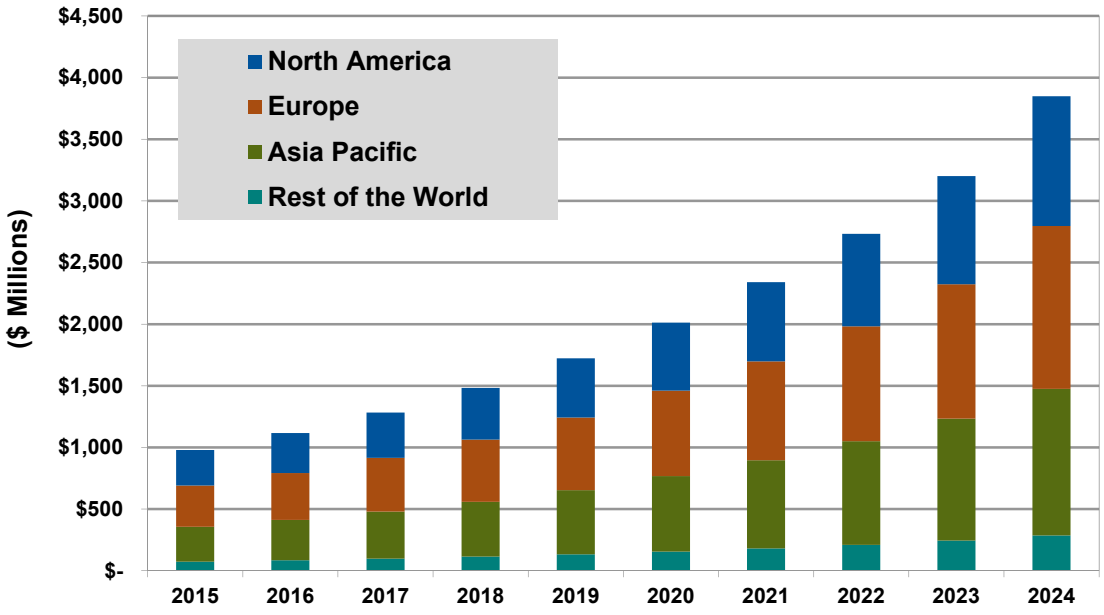
2.2.1 Market Impact

Navigant Research expects worldwide BEMS revenue for the enterprise/office segment to grow from $979.3 million in 2015 to $3.8 billion in 2024 at a 16.4% compound annual growth rate. The enterprise/office segment of the BEMS market is the largest worldwide in 2015, representing 41% of market share, followed by retail and then government with 17% and 14%, respectively.

Chart 1 BEMS Revenue by Region, Enterprise/Office Segment, World Markets: 2015-2024



(Source: Navigant Research)

The benefits of intelligent building energy management software and services, or BEMSs, are amplified with IoT infrastructure. Specifically, Internet-connected wireless sensing and control devices have made it possible to aggregate and communicate data streams from distinct building systems to cloud-based analytics and deliver actionable insights for facility improvements. The following sections describe how IoT is helping to transform facilities into smart offices.

2.3 IoT and the Future of Data Acquisition

The IoT trend is changing the process of acquiring building data. Internet addressable and multifunctional sensors now are providing intelligence at the edge; in other words, these data sources are gathering comprehensive data throughout the intelligent building. They are becoming cheaper and are being installed in equipment such as wall switches and lighting fixtures. These advanced devices gather data around a range of building conditions such as temperature, humidity, lighting levels, and occupancy counts thereby providing a comprehensive data set that historically would have been gathered in silos. Such data can then be communicated via open wireless communications networks to cloud-based analytics. The bottom line is that an IoT platform approach delivers actionable information, not just more data.

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2.4 Use-Centered Control and Information

Navigant Research suggests that the next frontier for the intelligent building is the widespread adoption of use-centered control and information. In other words, the intelligent building delivers specific feedback from an employee or tenant about their heating, cooling, and lighting preferences to refine settings that improve their experience in the office space. There is a growing vendor landscape of intelligent building solutions for HVAC improvements demonstrating just how use-centered design can improve occupant comfort.

The emergence of open standards, wireless communications, and BEMS analytics are reducing hot and cold calls, optimizing operations and maintenance processes, and generating significant financial benefits through energy efficiency and better capital planning for equipment retrofits. BEMSs provide building owners and operators with better data on equipment performance and use to support more proactive management and planning for repairs and replacement.

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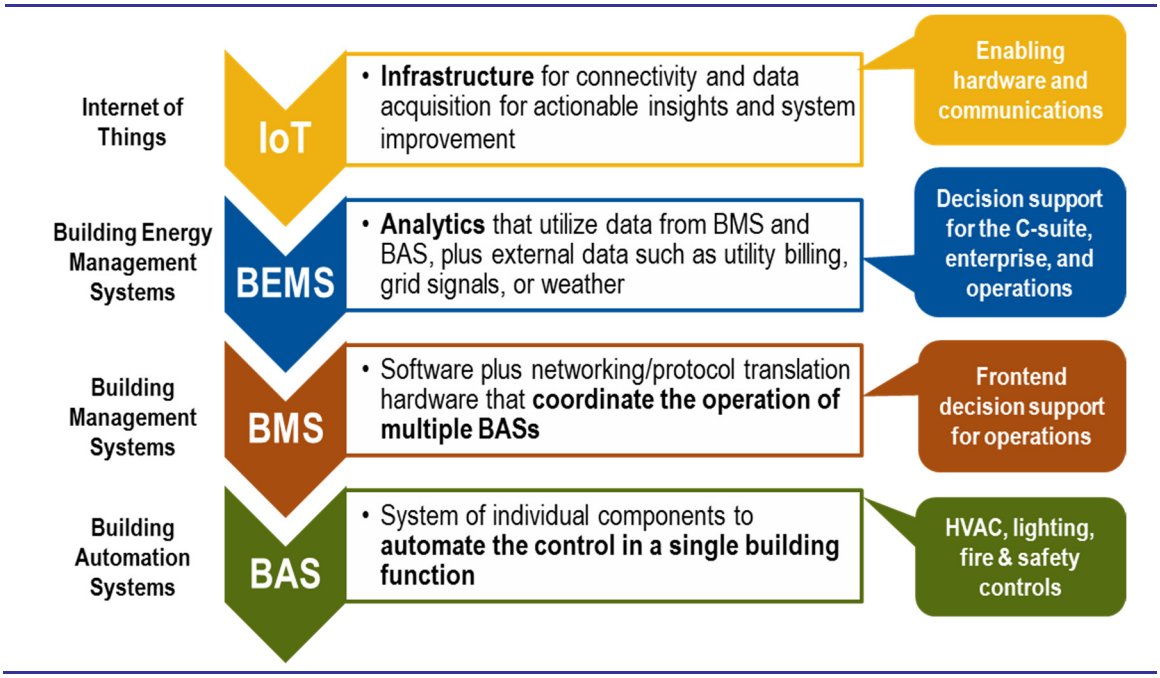
3. TECHNOLOGY PARTNERSHIPS FOR IOT IN BUILDINGS

Partnerships between technology providers are bringing new end-to-end solutions for the intelligent building by leveraging the core capabilities of different participants across the value chain. The following case studies demonstrate how one tech company is partnering with domain experts in energy and facilities management to deliver advanced IoT smart office solutions. Intel has announced a variety of partnerships that integrate intelligent gateways with innovative controls, automation, and software applications to improve the occupant experience and deliver significant energy savings. These examples illustrate how technology partnerships can heighten occupant satisfaction and improve energy savings with secure, scalable, and open architecture IoT solutions.

3.1 Partnership Landscape

When considering the technology stack of the intelligent building, there are traditional building controls, equipment, and IT devices, communications, software, and managed services. The introduction of IT-based analytics and services, or the BEMS market as defined by Navigant Research, has enabled the evolution of traditional facilities into intelligent buildings. A growing number of partnerships leveraging the core capabilities of vendors that provide solutions in the individual layers presented in Figure 2.

Figure 2 IoT-Enabled Building Intelligence



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The technology infrastructure of an intelligent building can be characterized by the stack of components in Figure 2. Moving from the bottom to the top of the figure above, the process of improving operations becomes more refined. Navigant Research defines each component as follows:

- **Building automation systems (BASs)** have been installed in commercial facilities for many years as a tool for managing system operations to meet occupant requirements for comfort. Navigant Research defines a BAS as a connected system of individual components, such as sensors, controllers, communications, and actuators, which automate the control of a single building function such as HVAC, lighting, fire and life safety, and security and access controls. The core of the BAS are the devices or systems that can operate automatically after programming or commissioning and are dedicated to a single purpose.
- **Building management systems (BMSs)** are frontend software and networking/protocol translation hardware offerings that are used to coordinate the operation of multiple BASs and provide decision support for facility managers, engineering, and maintenance.
- **BEMSs** are the monitoring and control solutions that provide insight into the performance of some or all aspects of the facility's infrastructure. They utilize data streams from the BMS, additional hardware such as submeters, and external sources such as weather and utility price signals. Essential for engaging executive decision makers, BEMSs are configured to translate building operational data into metrics that speak to the central pain points of executives by using key performance indicators, benchmarking, and financial analysis of energy spend and system performance.
- **IoT** is amplifying the capabilities of intelligent buildings as well as accelerating advanced control and sensors in commercial buildings today. Connected sensors that communicate via open protocols through a scalable and secure platform of IoT are providing new data streams and fine-grained control of building systems to maximize efficiency and occupant satisfaction.

As customers integrate the solutions from the bottom to top of the stack of sensing, control, and analytics technologies, there is greater opportunity to generate efficiencies both within an individual facility and across a portfolio. The concept of the fully optimized intelligent building promises access to energy, financial, and performance data in the metrics that speak to a wide array of users. From the CFO's mobile app to the engineer's fault detection and diagnostics interface, IoT platforms support configurable and actionable improvements in building operations. This intelligent building architecture is often delivered through technology partnerships.

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3.2 Partnerships to Optimize Occupant Comfort

Intel is working with Building Robotics, a human-centered software developer, to maximize employee comfort and improve HVAC operations. The solution leverages an IoT framework of intelligent gateways, wireless communications, mobile apps, and cloud computing to bring use-centered control and information to office workers. Building Robotics' Comfy platform provides a simple user interface that allows office dwellers to report hot or cold complaints and actively improve their environment. Comfy leverages Intel's IoT Gateway to communicate the feedback from the smartphone app of any engaged employee to a cloud-based analytics engine. This new approach essentially makes people the sensors in a commercial building. Once Comfy has identified the optimal temperature changes based on the feedback across the zone in the office, signals are then sent to the BEMS to adjust the HVAC system. Over time, the system's algorithm enables the building to be tuned to the occupants, as opposed to arbitrary setpoints. Figure 3 illustrates the Comfy solution architecture.

Figure 3 Building Robotics' Comfy Solution Architecture

(Source: Building Robotics)

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3.3 Two Partnerships to Maximize Energy Savings

KMC Controls and Intel are collaborating to generate greater energy savings across commercial buildings. The KMC Commander is a new solution that utilizes an Intel-designed process and security technology, an engineering design by Dell, and J2 Innovation software framework. All are integrated with enhanced KMC Controls automation systems in an IoT platform. This multidimensional partnership enables building operators to optimize HVAC system operations for greater energy savings and operational efficiency. KMC Controls created the Commander interface to control buildings via a smartphone app or web interface. Figure 4 illustrates how the KMC Commander quantifies operational improvements in terms of cost savings, water savings, and enhancements in comfort.

Figure 4 KMC Commander

(Source: KMC Controls)

Another example of collaborative development in IoT solutions is the partnership between Intel and Switch Automation. This partnership combines each company's strengths to deliver an end-to-end smart building offering. Switch Automation leverages the Intel IoT Gateway to enable cloud-based analytics of operational data and push actions back into BASs for automated efficiency improvements. The offering provides a single platform for monitoring and control of lighting, HVAC, access control, and other systems.

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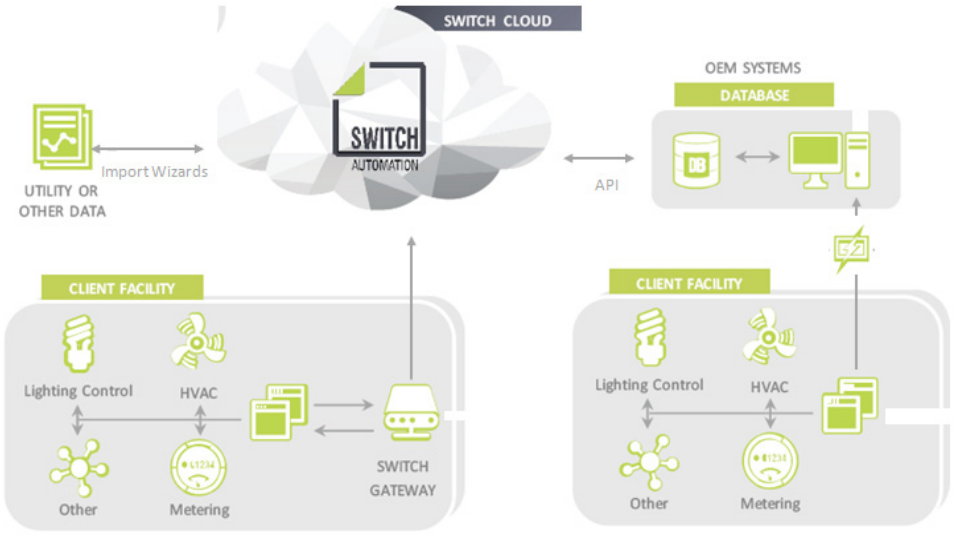
The Intel/Switch Automation solution is designed to provide building operators with convenient, web-enabled applications that deliver energy efficiency, enable ongoing operational improvements, and allow building operators to monitor and control lighting, air conditioning, access controls, and other systems remotely from a central platform. As illustrated in Figure 5, Switch Automation refines the process of aggregating and utilizing building data for operational improvements and energy savings.

Figure 5 Switch Automation Architecture



(Source: Switch Automation)

4. CONCLUSION

The IoT intelligent building platform is changing the way facilities are operated and maintained to deliver greater cost and energy savings while maximizing occupant satisfaction. The granularity of data gathered through advanced sensors and software applications is the basis of the actionable insights delivered through cloud-based analytics. Representing a significant shift from the traditional building management paradigm, intelligent building solutions utilize IoT-enabled technology to make ongoing system improvements that reflect the occupants' feedback on their office experience. This model of occupant engagement delivers a new kind of relevance by accounting for occupant feedback in ways never envisioned in the design of traditional building systems and thereby supporting the development of the smart office.

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