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Transforming buildings with the Internet of Things

How smart buildings deliver real, actionable insight and control for owners, operators, and occupants

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Executive Summary

Smart buildings combine the latest technological advances in the cloud, connectivity, analytics, and physical design to enable better visibility, greater efficiency and control, and more satisfied, productive occupants. In particular, the Internet of Things (IoT), a business revolution powered by technology, is driving rapid growth in the smart buildings space. Smart buildings offer benefits for building stakeholders of all types, including building owners, operators, and occupants.

The value of smart buildings stems from their ability to offer new levels of insight and control. This translates into four key areas of benefit: more efficient operations, optimized resource management, better space utilization, and greater occupant productivity. These benefits are made possible by smart devices and sensors, cloud connectivity, integrated business systems, machine learning, and productivity solutions.

Setting up a smart building solution involves connecting devices and sensors to the cloud, gathering insights from building operations, and optimizing the business processes using those insights. Microsoft offers industry-leading capabilities that help organizations at every step of their digital transformation.

The boundaries between the physical and the digital worlds are being redefined, and the commercial buildings space is no exception. Microsoft is the only company that can fully address the complex intersections involved in creating a truly smart building across devices and sensors, IoT, analytics, machine learning, business systems, cloud, productivity, and artificial intelligence. Microsoft has a proven track record in the IoT and smart buildings space, and continues to invest heavily in ongoing innovation.

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Introduction

What if buildings could communicate intelligently, proactively identify risks and inefficiencies, and address them automatically? What if you could streamline operations management, improve occupancy rates, and achieve double-digit savings in resource costs, all while enhancing occupants' experiences? Given the complexities of running a building, these possibilities may seem a long way off. But with today's technology, they are well within reach.

What is a smart building?

In some ways, the idea of intelligent buildings is nothing new. Many buildings have had "smart" elements for decades, such as motion-activated lighting and programmable HVAC systems.

Today, a smart building is one that combines the latest technological advances in the Internet of Things (IoT), the cloud, connectivity, analytics, and physical design to enable better visibility, greater efficiency and control, and more satisfied, productive occupants. It is a dynamic, responsive entity that adapts to changing conditions through connected building systems and a network of sensors and devices.

The foundation of a smart building is this network of connected things, which automatically senses and captures a tremendous amount of valuable information about the physical environment and its occupants, like temperature, light, occupancy, and even biometrics. That data is connected to other systems, analyzed, and used to enable more informed actions and decisions. These include automatic actions, like proactive alerts when equipment is at risk of failing, as well as better decisions about resource use, space, and more.

What is driving the rise of smart building solutions?

Thanks to the convergence of technology innovations and market demand, the smart buildings space is growing rapidly. Gartner estimates that by 2018, there will be over one billion connected things in smart commercial buildings.[1] With IoT solutions, buildings can extract data from a wide range of devices to realize a variety of benefits, from its infrastructure level to its occupants.

These technologies are now economically viable at scale. Hardware costs have fallen dramatically, making it more cost-effective to install smart sensors and devices in both new and existing buildings. Connectivity is ubiquitous, and standardized building protocols are in place, enabling things to connect to each other and to other systems quickly and easily. Cloud-based data storage, processing, and analytics make it possible to rapidly gain value from vast amounts of building information. These advances are not only driving growth in smart building solutions, but are also driving IoT growth more broadly. Whereas the business case for operational and energy optimization are generally understood, advances in affordability give IoT investments a compelling ROI in space utilization and productivity scenarios.

Over 1B

Connected things will be deployed in smart commercial buildings by 2018

Source: Gartner, 2015

[1] Gartner 2015. Smart Cities Will Use 1.6 Billion Connected Things in 2016.

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At the same time, cultural and demographic shifts are changing the kinds of experiences that building occupants expect. New workplace trends, like hoteling and hot desking, are shifting companies' priorities around collaboration and flexibility. Addressing these rising expectations can require the responsive capabilities that smart building solutions offer. Sustainability regulations and new accounting standards for leased space are also creating demand for smart-building capabilities. Essentially, building stakeholders of all kinds have something to gain from the implementation of smart building solutions.

Who stands to benefit from smart buildings?

In large part, smart buildings are becoming more prominent because they address critical needs of building owners, operators and occupants.

Many **building owners** are interested in smart buildings because they offer greater visibility into building operations and health. This enables owners to more closely manage costs and resources, address inefficiencies and improve space utilization. For most owners, it is difficult to get a holistic view of operations. They need a solution that enables their existing building systems to easily speak to each other. Smart building solutions can unify data across disparate networks and equipment to deliver a single view of what's going on, at an individual building level or across an entire campus.

Ultimately, owners are in search of ways to drive up the value of their properties while maintaining a high occupancy rate. They are largely focused on establishing an engaging and desirable occupant experience. For corporate owners, this often means enabling greater employee productivity. For commercial real estate firms, this means creating differentiated tenant experiences and potentially new revenue streams from new services. Smart building solutions can offer responsive spaces that enhance productivity and can support personalized, dynamic services and experiences that help attract and retain tenants.

Building operators share many of the same objectives as owners. This includes the desire for actionable insight, which enables them to reduce resource consumption, comply with sustainability standards, find opportunities for greater efficiency, and fine-tune business processes. Operators are especially looking for real-time information so they can fix issues faster, manage performance more proactively, and ensure occupant satisfaction. A hallmark of leading smart building solutions is their ability to offer this real-time, actionable insight via intuitive dashboards and other data visualizations.

Building occupants, both tenants and visitors, are attracted to the personalization, accessibility, and productivity benefits of a frictionless building environment. They are

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interested in responsive, engaging spaces that don't get in their way and that help them focus their attention on their core competencies. Here too, smart buildings are well-positioned to cater to occupants' changing expectations and offer the experiences they desire. With solutions like smart lighting and conference room automation, smart buildings can offer occupants unprecedented comfort and convenience.

What key benefits do smart buildings provide?

Real-time, actionable insight and control

Fundamentally, the value of smart building solutions comes from their ability to offer greater insight and control. With these capabilities, building stakeholders can uncover problems faster, perform maintenance proactively instead of reactively, improve processes, save resources, use space more effectively, and adapt to changing needs.

Microsoft has helped organizations of all kinds achieve greater insight and control through smart building solutions. We have a track record of investment and innovation in the smart buildings space, which includes implementing solutions across our own facilities that have saved the company millions of dollars.

Based on our experience, organizations are seeing insight and control translate into business value in four key areas: operational efficiency, resource management, space utilization, and occupant experience. As you develop a smart buildings strategy, it can be helpful to evaluate potential opportunities for your organization in each area.

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1. More efficient operations

Buildings today are complex organisms, with disparate systems controlling different aspects of building operations. Often, this means data lives in siloes, making it challenging to get a unified view of operations across an individual building, much less an entire campus. This lack of an integrated, centralized solution for monitoring and management makes it difficult to identify issues and inefficiencies.

With increasing pressures to maintain more assets with fewer people, building operators need ways to gain visibility faster and increase staff productivity. And in a world where unplanned downtime can be increasingly costly, proactively maintaining asset health is imperative.

Smart building solutions can help eliminate unknowns and provide end-to-end, real-time visibility. Through connected sensors and devices and intuitive dashboards, they provide immediate insight into what's happening within a building and across buildings. As data is aggregated over time, they can identify patterns in faulty equipment and uncover previously unknown problems.

Smart building solutions also empower your facilities workforce to execute faster and in a more strategic manner. A smart building detects faults faster and flags the root cause remotely, reducing the number of trips for in-person inspections. They help maintenance staff understand and prioritize the alerts they receive by business impact and associated costs. In many cases, problems such as a faulty HVAC control can be addressed remotely, freeing up staff to spend time on more strategic efforts. Smart buildings also have the potential to self-diagnose issues and implement solutions themselves, resulting in faster resolutions and a more comfortable building environment.

Perhaps most importantly, **smart building solutions enable proactive and predictive maintenance**. Through advanced analysis of historical building data, organizations can identify conditions that signal a risk of potential failure. When those conditions occur, the solution automatically triggers an alert or service ticket, empowering facilities teams to address the issue before a failure happens. This mitigates the likelihood of dramatic disasters and significantly extends the lifetime of operational systems and equipment.

The Sky's the Limit

See how Microsoft and the Otis Elevator Company are partnering to make over 2 million elevators smarter with predictive and analytical capabilities.

2. Optimized resource management

Building resource consumption can be costly. US firms consume approximately 18% of the nation's energy in their commercial buildings, at a cost of $180 billion per year.[2] Many organizations are looking for ways to reduce consumption — not only to reduce costs but also to achieve sustainability objectives and comply with regulatory mandates.

Smart building solutions provide the information and insight necessary to reduce resource consumption while minimizing the impact on operations. With real-time and cumulative visibility into energy, water, gas, and other resource use, organizations can make more informed decisions about resource allocation, such as adjusting usage schedules. Using analytics and data visualization capabilities, these solutions help to uncover previously unknown inefficiencies. They also track progress toward company

[2] US Department of Energy. 2016. BTO Multi-Year Program Plan.

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sustainability goals, and trigger alerts when there is a risk of exceeding predefined usage thresholds.

Just as importantly, **smart building solutions enable better control over resource consumption** by connecting otherwise disparate usage information into an aggregate, central view. This helps owners and operators identify inefficiencies and better navigate the challenges of balancing sustainability goals, budgets, and occupants' comfort.

Smart buildings can also proactively drive their own resource efficiency initiatives through automation and machine learning. For example, through asset monitoring, occupancy detection, and other ambient intelligence capabilities, buildings can automatically adjust the lighting in a room based on context and experience. These kinds of smart lighting solutions have the potential to reduce energy costs by 90% in office buildings and industrial installations.[3]

3. Better space utilization

Understanding and managing space utilization is a complicated effort. Many organizations lack visibility into how space is used, making it difficult to identify areas of over- or under-utilization. Consequently, space plans and construction strategies tend to rely on anecdotal evidence and sporadic surveys rather than objective, real-time data.

In addition, in 2018 and 2019, new standards issued by the Financial Accounting Standards Board and International Accounting Standards Board will eliminate the practicality of short-term lease solutions for both public and private firms. Compliance with these standards is expected to significantly change firms' balance sheets, and will establish space inefficiencies as a top concern for owners. Addressing these changes requires careful planning and coordination between operations and finance teams, as firms must adopt new processes for collecting and managing lease data.

With smart building solutions, building owners are better-equipped to cope with the new standards and drive improvements in space usage. These solutions leverage sensors and devices to identify areas that are underutilized or over-crowded. For example, they can produce heat maps to illustrate usage dynamics based on location and timing. With this kind of insight, firms can make more informed decisions that account for occupants' needs while eliminating wasteful spending. Better space usage data also improves planning for building expansions or retrofits.

Some smart building solutions go a step further, using intelligence and automation capabilities. They learn group and personal behavior and preferences to provide the most comfortable and supportive environment for the current scenario. They guide people immediately to the best available parking and direct internal traffic flow with customized access criteria. They connect people across more devices and locations, providing additional flexibility in how space is planned and used.

Smart building solutions also protect facilities and people in ways that many buildings cannot. With customizable access management systems, they can keep an account of all occupants before, during, and after emergencies. They control exactly who enters and exits with authentication and recognition technology. Using image analysis,

A More Sustainable Skyline

Learn how the City of Seattle is taking advantage of Microsoft solutions to reduce downtown building power usage by up to 25%.

An IoT Microcosm in Croke Park

Learn how Microsoft and its partners helped the Gaelic Athletic Association build a smart stadium to improve the safety and game day experience of over 82,000 fans.

[3] Gartner. 2015. Smart lighting has the potential to reduce energy costs by 90 percent.

facial recognition, and other artificial intelligence capabilities, smart buildings surface patterns and potential risks for better security decision-making and disaster prevention.

Smart building solutions also identify risks, breaches and other security issues and alert the right people automatically, minimizing response time**.** By digitizing closed-circuit television footage and analyzing it in the cloud, they can help security teams examine whole campuses for health and safety initiatives. A smart building records entrance information, occupant travel patterns, and room usage and gathers real-time input from occupants on what works well and what doesn't.

4. Greater occupant satisfaction and productivity

The norms of business culture are changing. A new generation is entering the workforce, ushering in a workspace revolution and higher technological expectations. More individuals are working remotely, and shared and open workspaces are becoming more common. Firms are looking for ways to attract and retain the best people and empower them to be productive. These and similar shifts in the landscape of work are driving a greater **focus on occupant experiences** and interactions with buildings.

Smart buildings offer both personalized comfort and personal assistance, in a manner that establishes trust, humanizes space, and sparks collaboration. They can automatically adapt to the occupants of a room based on their preferences and activities and immediately greet entering occupants with tailored lighting, temperature, and sound.

Smart buildings can also enhance meeting and collaboration scenarios with personalized, proximity-based automation and control, allowing individuals to spend more time being productive and less time struggling with equipment. When someone walks into a conference room, the building can identify both the person and their intent and can set up the environment accordingly.

Smart buildings reduce the burden of orchestration, freeing up occupants to focus on more important things. They complete administrative tasks, such as automatically recording meeting attendance or scheduling the optimal meeting room. With a broad knowledge base and a steady stream of real-time sensor inputs, smart buildings can understand context, learn behaviors, and identify intent behind actions. This means that they can take on more complex and nuanced tasks. The recent growth of personal biometrics will soon lead to even more ways to help people and groups be more comfortable and productive.

A Connected Campus

Discover how Pace University is using Dynamics 365 and Microsoft's Cloud Productivity services to enrich the educational experience for their students.

Setting up a smart building solution

No matter what kind of buildings you own or operate, you can likely benefit from a more intelligent, connected building environment. Microsoft offers a portfolio of solutions that can help you at every stage, whether you're just getting started or whether you are looking to optimize what you have.

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Connect devices and sensors to the cloud

Smart buildings require devices and sensors that collect on-the-ground data about building operations and health, environmental conditions, resource use, occupancy and more. When devices and sensors are in place, the next step is to ensure they are connected to the appropriate systems for data collection and management.

With Azure IoT technologies, you can connect virtually any device or sensor of your choice, as our capabilities are hardware- and platform-agnostic. Microsoft's cloud platform is incredibly open and flexible, enabling us to work with your existing building automation and building management systems and other types of applications.

Gain visibility

The next step is to aggregate data to gain visibility and insight. This involves data processing, storage, analytics and visualization capabilities that translate streams of real-time device and sensor input into actionable information.

Microsoft's analytics solutions bring together powerful Big Data, BI and visualization capabilities to transform complex building data into valuable insights. Stakeholders of all levels, even those without deep data analysis skills, can quickly generate and share rich, interactive reports that help uncover trends and drive the right actions and decisions.

Optimize business processes

Armed with visibility and insights, the next stage involves exercising greater control: applying those insights to improve business processes. IoT connectivity gives you the ability to not only listen to a device or sensor, but also to interact with it remotely. This might involve running diagnostics, changing operational settings, or pushing out new configurations remotely. This might also involve new forms of automation, like an automatic scan when a temperature reading exceeds a predefined threshold. Smart buildings can also learn to make predictions and optimize themselves, based on usage history and trends, and execute proactive services to reduce asset downtime and costs. They let occupants set up their environments to their personal preferences.

These solutions don't always need to immediately be applied widely. IoT solutions give you the flexibility to experiment and iterate at a smaller level. Once a solution is tested and ready to implement broadly, you can scale across an entire campus, even one that is globally distributed.

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Why Microsoft for smart buildings?

The boundaries between the physical and the digital worlds are being redefined, and the commercial buildings space is no exception. Many companies today can offer connectivity, building automation, and building management. But Microsoft is the only company that can fully address the complex intersection of devices and sensors, IoT, analytics, machine learning, business systems, cloud, productivity, and artificial intelligence.

We offer leading IoT solutions. Microsoft's premier cloud platform includes pre-configured IoT solutions for common scenarios like remote monitoring and predictive maintenance. Our platform is open and flexible so you can connect to any device, integrate with existing building systems, and use existing data and processes. We deliver end-to-end security, have more compliance certifications than any other cloud provider, and lead the industry in customer advocacy and privacy protection. Our approach lets you start quickly, experiment, and scale globally when you're ready.

We transform data into actionable intelligence. Microsoft is on the forefront of applying advanced analytics capabilities like machine learning to the world of buildings. We can predict failures before they happen, and systematically prevent them—even across millions of devices spread across the globe. Microsoft also offers powerful, self-service analytical tools to drive better decision-making for everyone, not just data experts.

We know productive experiences. Microsoft understands the enterprise worker better than any other company. With decades of proven experience in the enterprise workspace, we are industry leaders in productivity solutions. We have a full portfolio dedicated to letting people explore information, assemble ideas and tell stories naturally. We are built on a platform that allows people to shift their experiences fluidly and securely, and even extend them into their physical environment.

We have a winning partner ecosystem. Microsoft has hundreds of thousands of partners, spanning all kinds of services, industries, and locations. From energy management to campus security, our partners build on our powerful cloud, analytics, and productivity foundations to produce tailored building solutions. Microsoft partners can collaborate to provide you a comprehensive solution, specifically designed for your people and processes.

88 Acres: City of the Future

Microsoft itself has already taken advantage of smart building solutions on its own campus in the Seattle area. A team worked to unify an incongruent network of sensors from different eras, using a data-driven solution built exclusively with off-the-shelf Microsoft software. By stringing together thousands of sensors and harvesting billions of data points per week, they developed a solution that is slashing the cost of operating the campus' 125 buildings.

Instead of completely redoing building infrastructure, Microsoft created an "analytical blanket" that sits on top of the diverse existing systems used for building management. The software blanket enables equipment and buildings to talk to each other, giving building managers and engineers both a big-picture and granular view of the campus, like how many kilowatts of energy are consumed across Microsoft headquarters or by one piece of equipment. The software identifies issues large and small, and even prioritizes order by overall impact to the company. Algorithms can balance out the cost of a fix in terms of money and energy being wasted with other factors such as how much impact fixing it will have on employees who work in that building.

With this solution, facilities engineers can do an even better job of managing the health of Microsoft's buildings. They can fix most problems right from their desks, and can detect even the tiniest issues from a central dashboard rather than having to jump into a truck to go find and fix the problem in person.

Microsoft's smart buildings experience demonstrates how business can save energy and millions in maintenance and utility costs with relatively little up-front investment. Today, Microsoft and partner teams are now helping building managers across the world deploy the same solution.

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Conclusion

At Microsoft, our mission is to empower every person and every organization on the planet to achieve more. As we shift into a new era of ever-increasing information, the world needs platforms that allow us to get the important things done, while still engaging with and focusing on the world around us. This requires capturing and connecting vast amounts of data, translating data into insights, and enabling more productive experiences. For many businesses, realizing these benefits will require digital transformation.

Microsoft is one of the few companies in the world with the critical assets you need to succeed in the long term: a global hyper-scale cloud, analytics, big data and machine learning expertise, and unsurpassed productivity experience. Microsoft and our partners have worked with customers for years to develop integrated, innovative IoT and smart building solutions, and we continue to invest in these areas. This includes advancements like automated facial recognition, natural language processing, and other artificial intelligence capabilities that are expanding the boundaries of what a smart building can do.

Your business isn't static. Why should your buildings be? We invite you to consider how you can take advantage of Microsoft technologies to transform the way your buildings work, for now and for years to come.

Learn More

- See how Microsoft is using smart building technology on their own campus
- Check out Microsoft's IoT offerings at www.InternetofYourThings.com
- Keep up on the latest IoT research, customer stories, and market insights with the Microsoft IoT blog
- Discover how to make the most of your IoT investments

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