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# Advanced Smart Facilities Management with IoT

## WHY IT'S TIME FOR YOUR BUILDINGS TO HELP MAINTAIN THEMSELVES

### Concepts

- Why IoT-based smart facilities management is a smart investment
- The top five real-world applications of IoT smart facilities management technology
- Technological considerations for an IoT smart facilities management solution

# EXECUTIVE SUMMARY

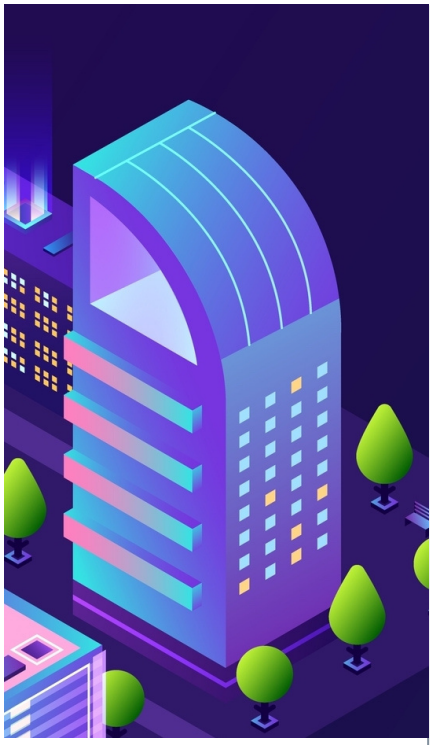
The concept of smart facilities management—and the concept of smart buildings—have been around for decades.

Smart facilities management (SFM) began with building management systems (BMS). A BMS is a computer-based solution installed in buildings to monitor and manage various systems, such as heating and cooling, electricity, and ventilation. Over the years, BMS has become more advanced with the addition of communications protocols and networks, but it has several limitations.

A BMS system can gather a lot of data, but unless it is properly analyzed, it won't help facilities managers perform their jobs better. Additionally, most BMS systems do not monitor smaller equipment in buildings, leaving these assets out of the remote monitoring and maintenance solution. It can also be difficult to scale BMS systems. If you oversee a number of buildings, each may use a different BMS vendor—and these solutions typically don't integrate easily with each other.

Fortunately technology gets smarter with the passage of time. Internet of Things (IoT) technology is making smart facilities management easier, more efficient, and more powerful. The good news is that if you already have a BMS system in place, you don't necessarily have to replace it. You can implement IoT solutions and make your legacy BMS system smarter, all at the same time.

In this white paper, we will first take a closer look at the top advantages of IoT technology for smart facilities management. Then, we will discuss some of the technological components to consider when implementing a smart facilities management IoT solution. We wrap up by outlining five real-world applications that clearly demonstrate the value facilities managers can reap from an investment in IoT technology for building management operations.



## Why IoT-based smart facilities management is a smart investment

### Cost savings

With IoT, building and facilities managers can realize can realize significant savings in three key areas:

- *Energy* - Smart energy systems reduce the costs associated with the utilities required for facility operations by making more efficient use of lighting, and optimizing heating and cooling systems

- *Equipment* - repairs and replacements—IoT technology helps facilities managers stay on top of routine maintenance and address equipment issues as they arise or, even better, before they arise. Managers are able to extend the life of assets, reducing the costs of repairs and replacements.

- *Resource optimization* - Facilities managers can use the data gathered from IoT devices to better allocate resources and staff on issues needing attention.

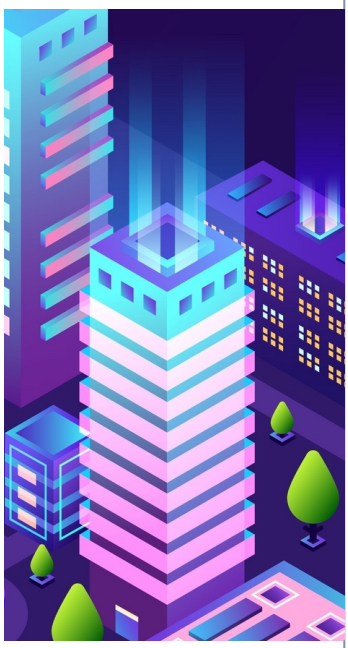
### Increased value of building assets

Equipping buildings with smart facilities management, including using the Internet of Things technology to control systems, adds value to those buildings.

The ability to monitor and control all aspects of building management and optimize maintenance keeps buildings in better condition, which slows the depreciation of a building over time, and enables them to be properly maintained with less labor. Advanced technology solutions are a draw for investors or buyers if you're looking to sell a property or bring others on board for expansion.

### Occupant demand

People have come to expect advanced technology in all parts of life, and buildings are no exception. Buildings that offer smart technology solutions to make life easier and more comfortable for occupants will attract more tenants. Higher demand translates to higher rents. An investment in IoT for smart facilities management can start to pay managers back almost immediately.



## The top five real-world applications of IoT smart facilities management technology

### Improved energy efficiency and sustainability

Commercial buildings are responsible for nearly 20 percent of energy use in the U.S., yet almost 30 percent of the energy is wasted. The implementation of smart building technology, however, can lead to a 30 to 50 percent reduction in energy costs.

Examples include:

- *Lighting control*—Sensors that monitor the amount of daylight coming into the building throughout the day can adjust the brightness of indoor lighting accordingly. On a bright day, for example, the sensors may dim or completely turn off the lights in a given area that is well-lit by sunlight.

- *Carbon dioxide monitoring*—CO2 sensors can monitor the amount of "stale air" inside buildings and introduce fresh outside air when CO2 levels are too high. The system can match the flow of outside air to appropriately match the needs of the number of occupants. The result is reduced strain on heating and cooling systems and energy savings, while also avoiding "sick building syndrome."

- *Shared HVAC workloads*—IoT technology enables individual HVAC compressor units to communicate with each other and share data. If, for example, one unit is operating below capacity and another area of the building needs additional cooling, one compressor unit can actually share refrigerant with another. IoT sensors keep these units running smoothly and efficiently, optimizing workloads and usage.

- *Carbon footprint reduction*—All of the energy savings made possible by IoT technology reduce a building's carbon footprint. Buildings that can demonstrate improved sustainability also attract more tenants.

## Predictive maintenance

Sensors can be installed on all types of building equipment, large and small. Real-time data provides valuable information on items such as power usage, vibrations, pressure, and temperature.

When measurements fall outside of a normal, healthy range, an alarm is triggered that alerts facilities managers. Small issues can be addressed and corrected before they become larger, more expensive problems (or complete breakdowns), which reduces downtime and the cost of repairs.

Real-time data on machines and other equipment also enable facilities managers to predict when routine maintenance needs to be done. Managers can optimize maintenance, making sure the equipment with the greatest need gets serviced first. Any required parts needed for maintenance can be ordered ahead of time, keeping maintenance operations running smoothly.

Optimized maintenance also allows managers to make the best use of the staff caring for and repairing the equipment.

To drive home just how valuable predictive maintenance is, here are a few stats.

- Seventy percent of malfunctions with machines can be predicted by gathering data from sensors and performing the proper analytics.

- One real estate maintenance company saw a 50 percent reduction in equipment failures and a 25 percent drop in maintenance costs after implementing IoT predictive maintenance techniques.

## Data analytics and metrics

We mentioned earlier that BMS systems gather a lot of data. With IoT, that data can get put to good use. Artificial Intelligence (AI) and Machine Learning (ML) technologies can be applied to the data gathered to unlock trends and patterns that can help facilities managers use resources more efficiently and improve overall building operations.

Data on exactly how much energy the building is using can help managers develop plans to reduce energy consumption, and help managers determine where to invest in improvements. For example, certain pieces of equipment may be closer to the point of replacement than others of the same age; having the performance data that lets you understand that is very helpful.

Data analytics not only helps facility managers make better decisions, it also gives owners and managers the metrics they need to measure how much value IoT investments are bringing to management operations. If a manager can see hard numbers pertaining to the energy consumption from specific areas of a building and how they improve after IoT sensors are put in place, it becomes easy to prove the ROI and build the case for future investments.

## Improved occupant experience

IoT technology works in many ways to make life inside a building more comfortable:

- *Improved air quality*—As we mentioned earlier, IoT sensors can monitor CO2 levels in the air inside the building. When the CO2 levels will begin to negatively impact the occupants, the sensor can initiate an action that increases the air flow to that specific area.

- *Temperature regulation*—The temperature inside a building can be automatically sensed, monitored, and controlled at various locations. The benefit of using IoT to do this is that the changes in flow and temperature are only turned on as needed, which not only keeps occupants comfortable, but also saves on costs.

When occupants are more comfortable, they tend to be happier and more productive. They are more likely to remain in your building.

## Enhanced COVID-19 health and safety protocols

The pandemic has ushered in a new wave of health and safety measures that have impacted every industry. Facilities management is no exception. Fortunately, IoT technology can help here as well, by creating an environment that supports social distancing and helps promote occupant health.

Let's take a look at some specific examples of how IoT and other advanced technologies can help stop the spread of COVID within buildings.

- Touchless entry through facial recognition or other bio identity methods keeps contact to a minimum.

- Automatic temperature scans at entryways monitors occupant and visitor health.

- Automated alerts in elevators or meeting rooms ensure that the maximum number of people allowed to gather in one location is not exceeded.
- UV-light sterilization integrated into air conditioning improves air quality.
- Cleaning robots sanitize facilities on a regular basis.
- Voice-activated doors and elevators reduce touchpoints as occupants move throughout the facility.
- Self-cleaning surfaces can be used for chairs and other pieces of equipment in communal areas.
- Carpeting embedded with LED lighting provides cues to help with social distancing.
- Increased air flow to high-traffic areas improves indoor air quality.
- Air sensors constantly monitor indoor air quality.
- The data gathered regarding air quality and traffic flow can help prioritize areas that should be sanitized more frequently.
- Analytics on temperature data provides an overall view of occupant health (this data can trigger an alert if it begins to trend upward).
- A mobile app can track where occupants go within a building and can assist with contact tracing should a positive case arise.

This list goes on, but it is evident that IoT technology will play a bigger role in facilities management as part of the battle to protect occupants against COVID.

## Technological considerations for an IoT smart facilities management solution

As with every IoT implementation, decisions fall into certain categories. Here are the main four areas you will need to include in your plans.

### Gateways and communication protocols

All devices and components in an IoT smart building system need to communicate with each other. This happens via a gateway, which relays data between two or more devices or components.

There are many communication protocols to choose from when configuring gateway connections, so you want to make sure you choose the best ones for your facility or building—or for a particular purpose. It may not be easy, for example, to get a network connection up on your roof. Wireless communication to the cloud is often a necessity, but this can drain power. There are several low-power alternatives that deliver the required result.

Examples include:

- *Bluetooth/Bluetooth Low Energy*—Bluetooth technology uses UHF radio waves to transfer data. Bluetooth is best for short-range data transmission. Bluetooth Low-Energy (BLE)—aka Bluetooth Smart—is the low-power version of the technology. Applications using this technology can run on a small battery for several years. Bluetooth Low-Energy is ideal for IoT devices that only need to exchange small amounts of data over a short distance. BLE offers a high data transmission rate and is a low-cost option, but it can only support a limited number of connected devices.

- *Zigbee*—Zigbee is a short-range, low-power wireless standard that is a specific type of Low Power Wide Area Network (LPWAN). LPWANs deliver long-range communication through inexpensive batteries. Zigbee

is beneficial for IoT because it increases the range of coverage by transmitting and relaying data over several sensors, creating an IoT mesh network. Zigbee is ideal for medium-range IoT systems and applications in which sensor nodes are located relatively close to one another and equally spaced.

- *Z-Wave*—Z-Wave is a wireless communication protocol designed to transmit packets of data at 100 kbit/s. Interestingly, it operates at a different frequency in each country. Z-Wave is a proprietary software supported by the Z-Wave Alliance. It is updated on a regular basis, which is a definite advantage. It is a low-power solution. Z-Wave devices from different manufacturers are compatible with one another. However, it can be more costly, and due to its limited capacity for data transmission, it is better used for items with smaller data needs such as light bulbs.

- *6LoWPAN*—IPv6 over Low-Power Wireless Personal Area Network is an open standard communication protocol defined by the Internet Engineering Task Force (IETF). It was designed to allow smaller devices with limited processing capabilities to become part of an IoT network and transmit data. 6LoWPAN can operate on multiple frequencies. The gateway is easier to implement compared to Zigbee and Z-Wave, but it is not used as often and the required hardware for implementation tends to be more expensive.

## Hardware

IoT hardware required for a smart facilities management system includes:

- *Sensors*—IoT sensors record data such as temperature, humidity, vibrations, or gas. They can also send alerts and triggers when a given threshold is hit, and record events that occur.

- *Beacons*—Beacons are wireless IoT devices that transmit data using Bluetooth technology.

They may be used to monitor asset/equipment health or for identity verification for security purposes, among other applications.

- *RFID tags*—RFID (Radio Frequency Identification) are passive tags that use radio waves to send small amounts of data over small distances. Common smart facilities management applications include asset monitoring and location tracking. Placing RFID tags on critical assets enables technicians to scan those tags to obtain information on the asset, such as maintenance history or service instructions.

- *NFC tags*—NFC (Near-Field Communications) tags are an alternative to RFID tags to obtain similar results. They cost less than RFID tags, and can be read by standard mobile devices such as smartphones. The tradeoff over RFID is that the reading device must come into contact with the tag, which may be difficult in some installations.

- *Microcontrollers*—Microcontrollers play a big role in delivering low-power embedded systems. Embedded systems consist of physical objects into which digital intelligence has been built in or "embedded." A microcontroller includes a processor, memory, and input/output peripherals on a single microchip. It is the workhorse of embedded systems, responsible for controlling and carrying out specific functions, and comes in many different forms with varying approaches to communications and power consumption. Selecting the right microcontroller for the device application is a critical step in design of the device.

## Software

Your IoT devices will make rivers of useful data available to you, but doing useful work with that data requires software. There are many commercially available facilities management software platforms that may be able to handle this data, but there are limits to what a general

purpose tool can do. Often, you will need to build something custom to manage your specific needs.

The specific utility of that software is driven by what systems you are monitoring and how your staff intends to use the data gathered from those systems. Understanding what software to build requires working closely with those users to ensure that their needs are met. That part of the process is critical. In addition, there are some general software design factors to keep in mind when designing and developing such an IoT application:

- *Usability*—Is the software easy to navigate and use? People in facilities management are often technically adept, but perhaps are not experienced with complex software. How easy is it for users to do something meaningful with the data presented in the application? Have you tested the software as you've been developing, with real users, so you are sure about what they want to do, and how they want to do it?

- *Functionality*—What do your users really need to be able to do with the data? How should the data be presented? Are there specific analytics that they use or metrics that they study? What types of sorting or filtering options would work best? How often should the data be displayed?

- *Security*—It is essential to build application security into the development process from day one to make sure all of your data is protected and secure—both at rest and in transit. Your physical infrastructure is critical to your business operations and must be protected.

A prototype or mockup is often a great way to start the software design process. You can show this to real users and let them interact with the mockup. Gather feedback and update the mockup until users are satisfied with performance and functionality.

Creating an interactive prototype can save you a lot of time and money in the development process and prevents

you from wasting resources on unnecessary features or a design that is not user-friendly. A prototype also helps you make sure you can get the desired functionality within the power constraints of your system.

## Data capture and analytics

It may be tempting to collect and analyze every piece of data possible about your facility. But this is not usually the best approach.

We recommend deciding up front what data you want to capture and why. For example, do you need to record a temperature reading every second, or is once an hour sufficient? Does the data you wish to capture serve a specific safety, maintenance, or financial purpose? Mapping out requirements ahead of time ensures you choose the best sensors and other devices for overall system performance and ROI.

Beyond deciding what information to capture, an equally important decision revolves around where to process and store the data. Much of the data processing decision boils down to speed. Do you need the data reported hourly, daily, weekly, or monthly? Or, do you need analysis completed in seconds, milliseconds, or microseconds?

If you need faster data processing and real-time insights, you may want to process data at the edge of the network in a gateway device of some sort. We refer to this as working in the “Fog.” The Fog is the space between the edge of the system (where the sensors are) and the cloud. It operates close to the data source, but has enough power and bandwidth to process/analyze more data and communicate over longer distances.

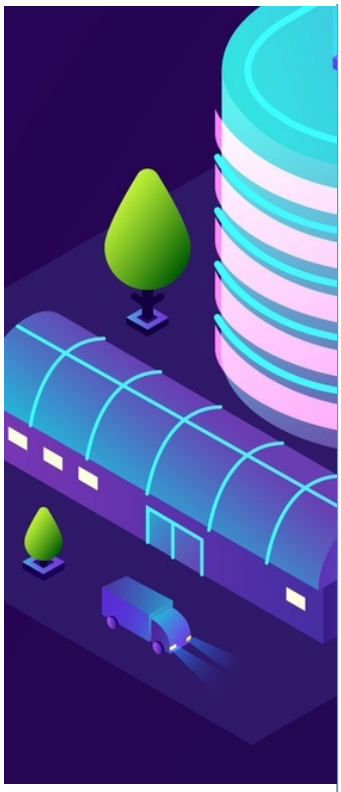
Fog processing may also be a better approach when connectivity to the cloud is limited. Data that is less time-sensitive (such as information for preventive maintenance) can be sent to the cloud less frequently for further analysis.

When it comes to analyzing the data, you may be able to use an off-the-shelf analytics package or you may need a custom solution to fit your needs. You will need to research the options to make the best choice, or work with someone who can make the right recommendation for you.

As you make your way through these four areas, there is a cost/power/functionality battle that is constantly in play. A balance must be struck between the overall cost (as determined by your budget), the power constraints on the system, and the desired functionality of the full system. When designing a smart facilities management IoT solution, you will need to make decisions throughout the development process that will ultimately shape what the system can do. If you take the time to plan ahead, you can stretch your budget and get the maximum benefit out of every dollar.

Selecting the best IoT sensors for the various environmental conditions in your building and using the right microcontrollers can have a big impact on your bottom line and on the performance of your IoT system. You may also be able to take advantage of low-power modes on certain devices at specific times of day or power off certain components when not in use. Choosing the right communications technology also influences cost and performance.

A skilled team with expertise in designing IoT systems and applications can present you with the best options that fit within your budget while still delivering the maximum amount of power and performance.

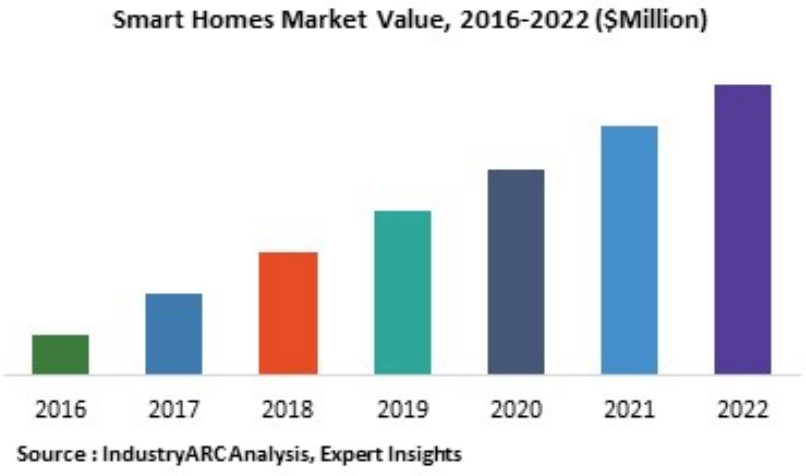


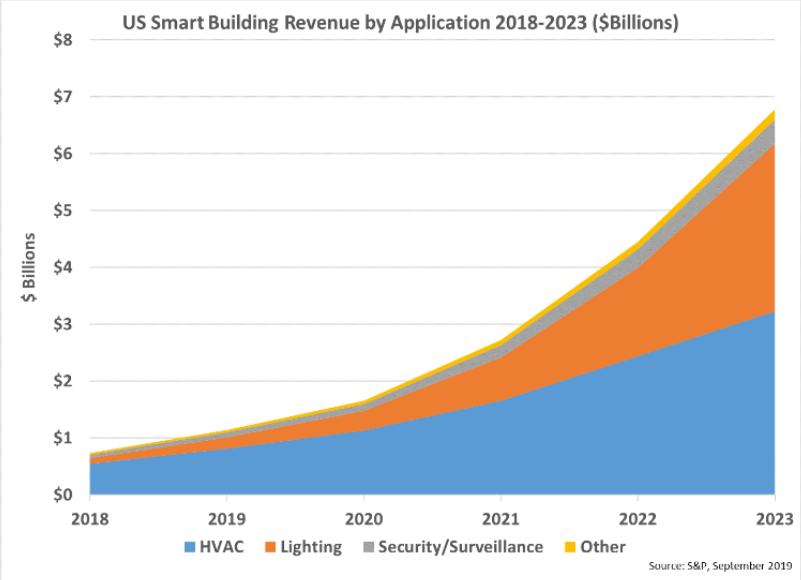
## Conclusion

The smartest building and facilities managers are making the investment in IoT technology because it reduces operational costs, adds value, and improves the quality of life for occupants. In fact, the smart building market is expected to experience a Compound Annual Growth Rate (CAGR) of 12.5 percent between 2020 and 2027.

Facilities managers who want to remain competitive should make the move to an IoT implementation now. The pandemic has made the switch even more urgent for facilities managers. The ability to provide a safe and healthy indoor environment that keeps contact points to a minimum, actively supports social distancing, and monitors occupants and the indoor air for safety gives facilities managers a competitive advantage.

You can keep your buildings and facilities fully rented while lowering the costs required to run them with a smart facilities management solution fully powered by IoT. Reach out to our team of IoT application and embedded system experts to make the right decisions at every step of the design and development process and open the door to a smart building today.



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As evidenced by the chart above, smart buildings are definitely on the rise. The facility in which you run your business can have as much impact on how that business runs as the people who work within it. Property technologies like smart buildings help you manage that vital resource intelligently, efficiently, and safely. I hope this paper gave you a good high-level view of what is possible, but there is more to think and talk about. If you see the potential for this to help *your* business, send me a note and let's talk.

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