BRIEF
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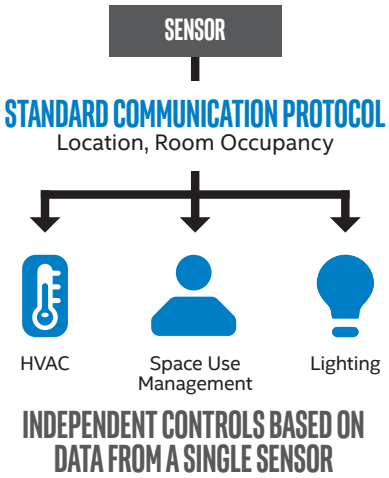
IoT Data Standards Provide the Foundation for Smart Buildings



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Introduction

Intel's smart factories use highly specialized Internet of Things (IoT) data specifications that make it possible to bring new factories online quickly and reliably by replicating identical processes from one facility to another. Imagine being able to do the same thing with other buildings, such as offices and airports. These buildings present different challenges than manufacturing facilities because, rather than data-based measures, they often use performance-based measures that can vary, such as green—or sustainability—certification. Without highly defined data specifications individual suppliers may be unaware of integration requirements between automated components, resulting in costly delays and rework.

Intel IT, in partnership with Intel's Internet of Things Group and industry-wide organizations, is leading the effort to establish IoT data standards and messaging protocols for smart buildings that allow vendors to provide integrated solutions. With these standards in place, functionality in non-manufacturing building projects can become as reliable, repeatable, and cost-effective as it is in Intel's smart factories.

The benefits—energy and cost efficiency, occupant comfort, better security, and state-of-the-art connectivity—are evident in implementations like Intel's Smart Building and Venue Experience Center in Chandler, Arizona. This smart stadium combines multiple functions into a unique, human-focused experience. But reaping the benefits of smart buildings requires a shift from performance-based standards to data-based standards, as well as closer working relationships between IT organizations and facilities management.

Our aim to develop IoT standards for smart buildings will allow us to use a Copy Exactly process for Intel's office buildings, similar to what we use for our factories—in essence, Intel's office buildings will become as "smart" as Intel's factories.

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Acronyms

HVAC	heating, ventilation, and air conditioning
IIC	Industrial IoT Consortium
IPSO	IP for Smart Objects
IoT	Internet of Things
LEED	Leadership in Energy and Environmental Design
OCF	Open Connectivity Foundation
SEMI	Semiconductor Equipment and Materials International
SCADA	supervisory control and data acquisition

Business Challenge

Smart factories use highly refined data specifications to support interoperability and consistency. This approach is especially important as the Internet of Things (IoT) becomes an increasing part of the factory infrastructure. The facilities infrastructures at Intel's factories use closely controlled supervisory control and data acquisition (SCADA) systems to enforce a predictable, consistent format for data gathering, extraction, storage, and analysis. Standard formatted data and messaging protocols enable process matching from factory to factory. When bringing new smart factories online, Intel uses its Copy Exactly process to replicate identical processes from one factory to another.

In order to realize the benefits that a smart building could provide, Intel is moving toward implementing a similar process for nonmanufacturing and office buildings. However, many non-factory building projects still use performance-based specifications. For example, Leadership in Energy and Environmental Design (LEED) certification ratings vary based on the building's level of sustainability. These performance-based specifications often have limited or no data structure standards and do not take into account the large amounts of data generated by IoT sensors and equipment. In addition, many suppliers have business objectives that lead them toward proprietary—or closed—systems. Businesses that want to integrate multiple solutions in their smart buildings today must negotiate end-state functionality rather than component-level requirements. But long-term consistency and reliability of smart building projects depends on highly defined data-based specifications. In order to fully transition to predictable and repeatable smart building construction, data format and messaging protocol design must begin before specifying and purchasing the first IoT device or software.

Smart Buildings Require More Interoperability

The difference between data-based and performance-based specifications can lead to difficulty implementing compatible components in a smart building due to a lack of concise requirements. Often, individual suppliers are unaware of integration requirements between their own deliverables and other technology within the building, resulting in silos and non-interoperability, which increase costs and delays. For example, a common performance specification in a smart building might be sensors to detect occupancy in a specific area in order to control heating, ventilation, and air conditioning (HVAC), lighting, and space use management. While three systems receive and act on the data, only one sensor is necessary. The challenge is that this single sensor must communicate its location and whether the space is occupied or unoccupied to all three systems, which were likely installed by three different vendors. Each of these vendors might

have used different network infrastructures and communication languages for their individual components.

Lacking clear IoT data standards for smart buildings, challenges and roadblocks can appear at every stage of the building process:

- **Project scope and budget.** Without clear specifications, project scope and budget may rely on assumptions of integration and interoperability that the design does not support.
- **Design.** Designs that do not include detailed standard specifications for IoT data and messaging protocols for interoperability are open to interpretation by vendors, resulting in non-interoperability.
- **Construction.** Installing a single sensor (instead of three) is the most efficient use of resources, but if clear standards are not defined, unforeseen integration costs can quickly escalate.
- **Maintenance.** Maintaining redundant IoT devices and the resulting data is more complex and costly when they are not integrated and compatible.

In our active factory model, we use communication standards defined by Semiconductor Equipment and Materials International (SEMI) as the equipment interface protocol for equipment-to-host data communications. In our automated factory, the interface can start and stop equipment processing, collect measurement data, change variables, and select materials for products. How the messaging is standardized—the messaging protocol—is the most important aspect, not the way in which messaging is transported. SEMI communication standards do this by defining a common set of equipment behavior and communication capabilities. Messaging is transported on top of the network communication layers. Standardization of the messaging protocols and equipment models in an Intel smart building—making production tools and sensors Plug and Play with the environment—can begin by using our factory as a model.

Intel IT's aim to develop standard IoT messaging protocols and equipment models for smart buildings would allow us to use a similar Copy Exactly process for Intel's office buildings.

Smart Buildings Require More Collaboration

One of the main challenges of building and managing smart buildings at Intel is the successful merging of two distinct knowledge domains—IT and Facilities. Intel IT manages all aspects of service delivery and support for IT equipment while Facilities manages the building functions, such as power and

Putting IoT Data Standards to Work

State-of-the-art sports stadiums are designed to dramatically improve fan experience and encourage people to attend a live event. These smart stadiums include interactivity that augments reality, such as real-time access to player profiles, statistical data, fantasy performance, as well as practical implementations such as which concession stands and restrooms have the shortest lines.

Intel's Smart Building and Venue Experience Center built on the Intel® IoT Platform and recently implemented in Chandler, Arizona, standardized more than a dozen smart stadium capabilities to support operational efficiency, enhanced fan experience, and better security. The goal was to create a fan experience and build a blueprint of the technologies that enabled that experience. Whether it is a retail store, a data center, or an office space, smart technology can improve the occupant experience.

The Experience Center uses reference architecture standards for smart stadium capabilities:

- **Fan experience.** Fans can use mobile apps to find friends, locate available parking, and get special offers. They can also order concessions from their seats, and sensors that detect cheering make the experience more interactive.
- **Stadium security.** Surveillance cameras detect unruly fans, while access to sensitive areas is managed with facial recognition.
- **Operational efficiency.** When restroom visit counts exceed preset numbers, maintenance orders are automatically generated. Managers can use mobile apps to monitor and change lighting based on occupancy.

Smart stadiums have proven benefits:

- **More profitable.** Smart stadiums help increase the sale of tickets, food, and merchandise, while modernizing building management systems that control HVAC and lighting. Through energy conservation, the building costs less and requires fewer people to run.
- **More secure.** Numerous cameras and sensors provide real-time data to security staff monitoring the crowd, helping to keep people safe. This allows stadium security and external police better collaboration, and provides important alerts that are rapidly broadcast to fans.
- **More fun for fans.** Stadium networks and mobile apps improve connectedness, convenience, and customer service. Fans enjoy shorter lines, better directions, and less hassles.

Intel IoT Gateways and standard communication protocols are critical components of the successful smart building, and they lay the foundation for future automation.

Benefits of Smart Buildings

- Energy efficiency
- Occupant experience
- Cost efficiency

HVAC. These two domains need to closely coordinate efforts when creating smart buildings so that their individual functions are highly integrated. Ownership of systems may also require redefinition. For example, once a device goes from manual, unconnected functionality to a smart, connected automation, Facilities and IT need to crisply define future ownership and maintenance responsibilities for those devices. Sharing data between the two domains becomes more frequent when the same sensor is connected to HVAC and lighting, as well as conferencing services.

Through cooperation between IT and Facilities, businesses can reap the following benefits of smart buildings:

- **Energy efficiency.** Automated environmental controls make efficient use of energy by shutting off lights and reducing HVAC requirements when areas are not in use.
- **Occupant experience.** Building occupants enjoy consistent temperature and lighting, and integrated communications technology improves collaboration and productivity within the building and with employees in other locations. Employees can also easily find available space, even when meeting rooms appear booked but are not in use.
- **Cost efficiency.** Not only can building managers remotely identify when equipment needs servicing or replacement, but they can also monitor and control multiple buildings around the world from one location.

The transition to smart buildings requires close collaboration between IT, Facilities, and other organizations within the enterprise.

Solution

To transform Intel's office buildings into smart buildings, we are working more closely with Facilities, as well as industry groups, in an effort to create data and messaging protocol standards and equipment models that improve current and future automation opportunities. This collaboration is helping us develop clear infrastructure requirements.

Working Together to Define a Vision

To secure and protect the enterprise in a smart building implementation, IT organizations must lead the way. Staying ahead of the business needs with cost-effective infrastructure readiness, deployment, and support are essential to success. Previous cloud-based implementations for energy management exposed challenges and highlighted outdated approaches to integrating building components. To address these challenges, we developed a clear collaboration strategy to identify gaps within our own infrastructure that prevent automation, and then we documented which group owned responsibility for each function, whether it could be standardized, and where to begin. We are now focusing on the highest value opportunities for developing an IT operating model, such as plumbing and infrastructure,

supply chain, manufacturing efficiencies, and design labs. The outcome will be basic standards for smart buildings.

By focusing on basic standards and requirements, rather than defining specific technology, vendors can develop solutions that integrate easily into our smart building environment. For example, in the factory, defining a specification that requires SEMI standards-compliant tools gives vendors room to develop their best solutions without being told how they must do this. And Intel's approach to smart buildings will help IT organizations take a leadership role in the industry to develop open architecture designs for sustainable automation.

Leading the Industry toward a Smart Future

Intel IT and Intel's Internet of Things Group (IOTG) are working to define the system architecture and requirements for engineer-to-engineer solutions. These specifications target individual operational functions that need to have knowledge of, and share data with, other operational functions, such as an occupancy sensor that transmits its location and status to multiple disparate systems.

IOTG develops data standards and architecture alignment products related to the Intel® IoT platform, which is central to smart building design and other applications. This area is where IT and Facilities are working together to deliver solutions that provide improved interoperability and increased manageability.

Intel IT and IOTG are actively engaged in developing an industry-wide standard for interoperability of devices by participating in leadership roles in the following organizations:

- **Industrial IoT Consortium (IIC).** Intel is a cofounder of IIC, which is an open membership, international not-for-profit consortium formed to set the architectural framework and direction for the Industrial Internet. IIC coordinates ecosystem initiatives to connect and integrate objects with people, processes, and data using common architectures, interoperability, and open standards.
- **Open Connectivity Foundation (OCF).** OCF is a newly formed entity whose goal is to help unify IoT standards so IoT solutions and devices can be developed to work seamlessly together. It unites the entirety of the Open Interconnect Consortium with companies from silicon, software, hardware, and finished goods. With OCF specifications, protocols, and open source projects, a wide range of consumer, enterprise, and embedded devices and sensors from a variety of manufacturers can securely and seamlessly interact with one another.
- **IP for Smart Objects (IPSO).** IPSO is an alliance whose goal is to define and support smart objects. The alliance focuses on object interoperability on protocol and data layers and identity and privacy technologies.

One Smart Standard

Smart buildings may be self-contained today, but how will they look in the future? Can a comprehensive set of Internet of Things (IoT) data standards transcend the physical building and encompass a broad set of functionality from supply chain to delivery of a finished product, regardless of the physical location? Can these standards carry us beyond?

An important goal of industry-wide collaboration on IoT data standards and the development of clearly defined base requirements is extensibility—one standard set of requirements that is ultimately flexible enough to encompass the logistics of smart buildings, manufacturing, and supply chain. For example, using a standard communication type connected to the building infrastructure through Intel® IoT Gateways, we can extract a broad range of different sensor and smart equipment data. Data centers, also connected to the Intel IoT Gateways, using standard connectivity and overlying messaging protocols become Plug and Play with any sensor type.

Conclusion

Reaping the benefits of smart buildings—energy and cost efficiency, occupant comfort, better security, and state-of-the-art connectivity—requires a shift from performance-based standards to data-based standards. In order to make that transition, IT organizations and facilities management must work together to understand how traditional knowledge domains overlap in the smart building.

Intel IT is working with Intel IOTG and industry-wide organizations to establish IoT data standards and messaging protocols. Our aim is to develop standard requirements that allow vendors to provide integrated solutions. With these standards in place, functionality in non-manufacturing building projects can become as reliable, repeatable, and cost-effective as it is in Intel's smart factories.

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We connect IT professionals with their IT peers inside Intel. Our IT department solves some of today's most demanding and complex technology issues, and we want to share these lessons directly with our fellow IT professionals in an open peer-to-peer forum.

Our goal is simple: improve efficiency throughout the organization and enhance the business value of IT investments.

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