



Look Inside.™

Solution Brief
Internet of Things

Designing More Affordable Smart Building Solutions

Intel technologies for the Internet of Things (IoT) help solution providers reduce the cost of smart building solutions while increasing tenant comfort.

Introduction

For owners and operators of small to large-sized buildings, the cost of adding smart-building technologies can be hundreds of thousands to millions of dollars (USD), making it prohibitively expensive for many. The high price tag is due, in large part, to closed, custom, and proprietary building equipment and software that can only be upgraded by the original manufacturer.

Until recently, the lack of a cost-effective solution has kept ODMs, OEMs, and systems integrators from being able to deliver affordable smart building management systems (BMS) to market. As a result, most small-medium building owners and operators do not have automated access to data in their buildings, thus making it very difficult to realize energy savings, lower maintenance costs, and improve overall building performance.

A lower cost alternative is to instrument a building using Internet of Things (IoT) technologies, including low-cost sensors, on-premises gateways, distributed control, and cloud analytics.

Instrumentation involves installing an independent collection of actuators and sensors (e.g., light, temperature) throughout a building to collect more information on the building's operation, such as utility usage. These sensors plus gateways can augment existing BMS sensors for improved monitoring.

“Smart building technology investments typically pay for themselves within one or two years by delivering energy savings and maintenance efficiencies. In smaller buildings that do not have centralized automation systems, the availability of affordable wireless sensors combined with this new smart building technology makes it possible to deploy a building automation system without the expense of hard-wiring,” according to Dan Probst, chairman of energy and sustainability services at Jones Lang LaSalle.¹

This solution brief outlines the business opportunity for smart buildings, and discusses how solution providers can deliver more cost-effective solutions using IoT technologies from Intel.

The Market for Smart Building Technology

Commercial buildings account for approximately one-fifth of U.S. energy consumption, with office space, retail space, and educational facilities representing about half of commercial sector energy consumption.² The U.S. Environmental Protection Agency estimates a 10 to 30 percent increase in building energy efficiency could be achieved with low-cost energy efficiency measures and operational adjustments,³ which presents a significant opportunity for solution providers and building operators.

Quantifying this expanding market, a recent study by Navigant Research forecasts revenues for global commercial building automation systems will grow from \$58 billion in 2013 to \$101 billion in 2021,⁴ as shown in Figure 1. The forecast comprehends the energy efficiency requirements of new and retrofit commercial building construction.

Building Management System (BMS) Overview

Analogous to a supervisory control and data acquisition (SCADA) system used in manufacturing, a building management system (BMS) monitors and controls various building systems, such as heating, ventilation, air conditioning (HVAC), and lighting with additional and often separate systems to control elevators, fire, safety, security, and access controls. The BMS supports a user interface (UI) that allows operators to program and maintain set-points, generate alerts on abnormal conditions, and execute scripts similar to a programmable logic controller (PLC).

In reality, many buildings do not have a fully

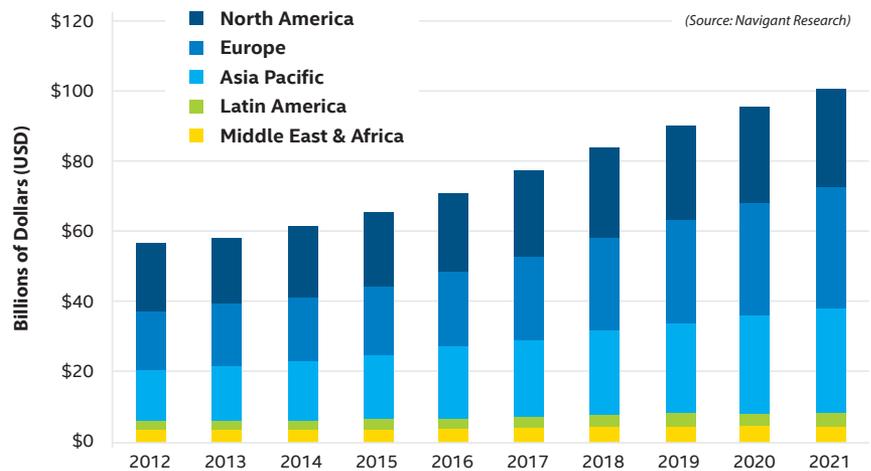


Figure 1. Commercial Building Automation Revenue by Region, 2012-2021

integrated management solution; hence, operators are required to expend considerable effort to manage multiple independent systems. Also problematic is today's building systems tend to be proprietary, expensive, brittle, and very hard and costly to modify or extend.

What IoT Brings to Smart Building Developers

The IoT is bolstered by proven tools and Internet technology for dealing with scale, integration, and complexity. These capabilities link all types of sensors using well-understood protocols (e.g., IP, HTTP, web server) and abstractions to simplify solution development. There are also methodologies, decomposition programming styles, and tools, including:

- RESTful services, web APIs, and publish/subscribe messaging pattern
- Machine human readability and interoperable representations (e.g., XML, JSON)
- Decoupled end points, OS independence, and seamless local/remote processing

- Open source software (e.g., Linux*, IP stacks, web server, databases, Hadoop*)
- Hosting and compute services (e.g., Amazon* Web Services (AWS) Google* engine, PaaS)

Supported by an innovative, vibrant, development community, IoT is expanding the connectivity and scale of machines and sensors throughout the world. Taking advantage of the resulting economies of scale, flexibility, and openness,

smart building developers using IoT technologies are well positioned to reduce solution costs by an order of magnitude compared to today's proprietary and closed building automation products.⁵

Figure 2 illustrates IoT system architecture that connects sensors and actuators to the cloud, either through direct connections or via gateways. Once the data is in the cloud, it is processed by data analytics software and services that provide building operators insights and control.

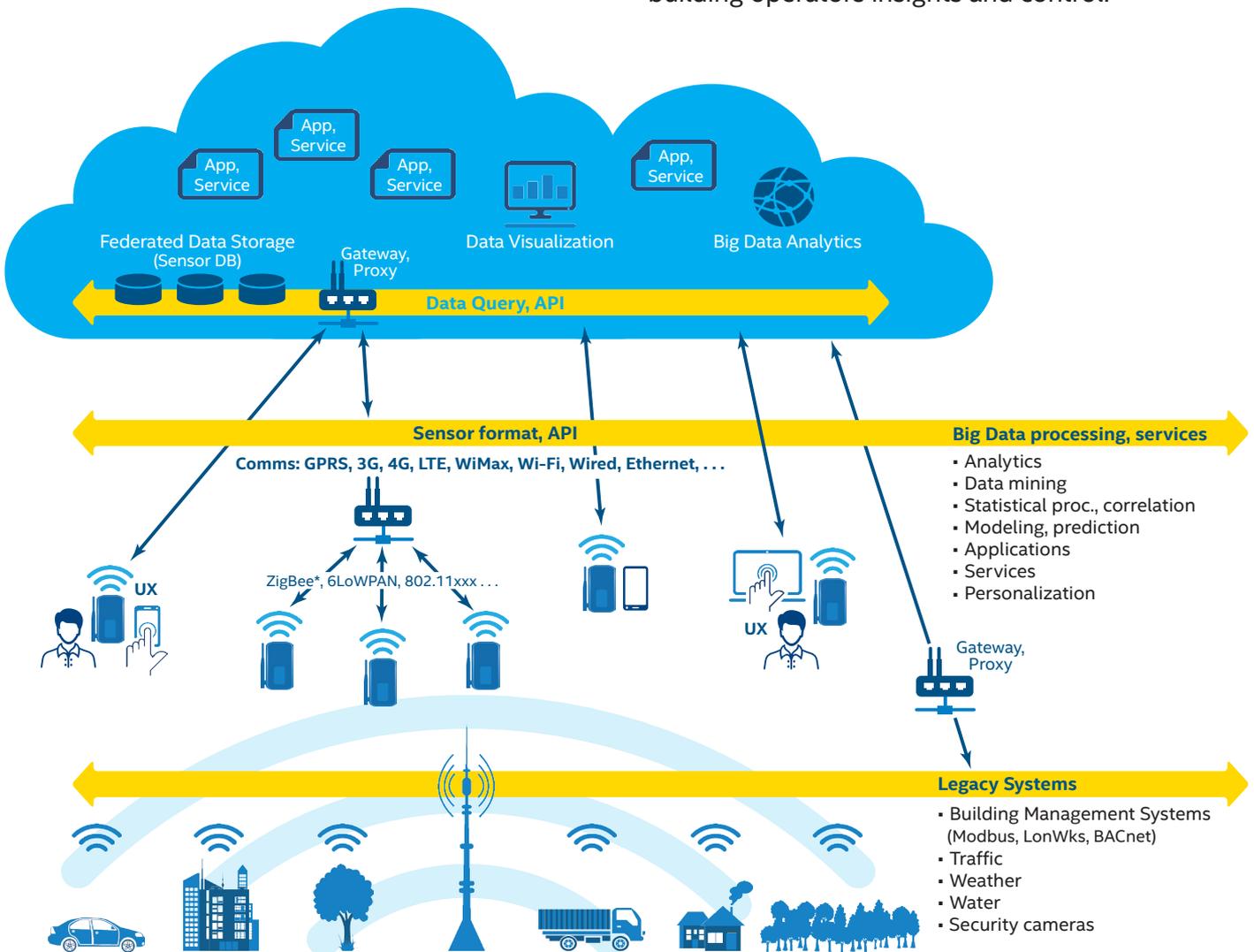


Figure 2. IoT System Architecture

IoT system architecture can be easily applied to building automation, as shown by the residential building example in Figure 3. Internet-enabled devices, like the electric use sensor in the figure, directly connect to energy web services, whereas non-Internet-enabled devices send data to the cloud via a gateway. Once the data is in the cloud, there is a wide assortment of tools and products available to process, visualize, and act upon the information.

Intel Solutions for Smart Buildings

Moving forward, IoT will drive nearly every building system to have built-in, secure, interconnected intelligence. Similarly, the

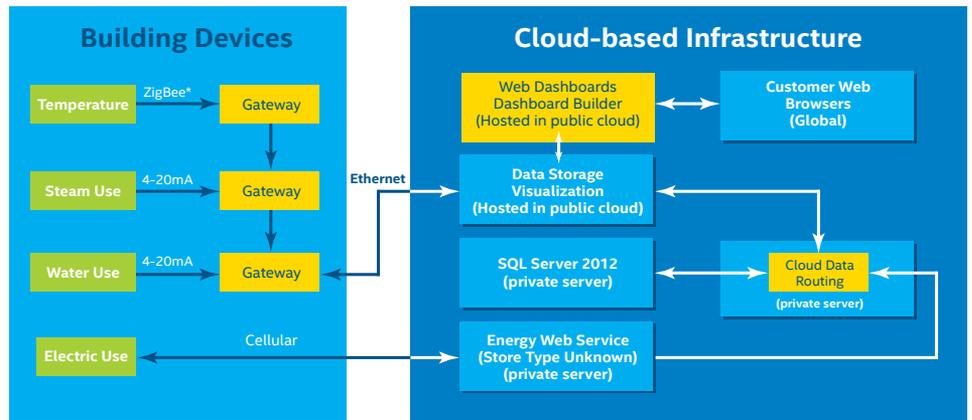


Figure 3. Residential Building Example

supporting network and cloud infrastructure will be enhanced to better protect data, manage devices, and perform data analytics. To deliver on a generic IoT vision, which can also be applied to building management, Intel developed a framework (Figure 4) to enable end-to-end solutions that join together a wide

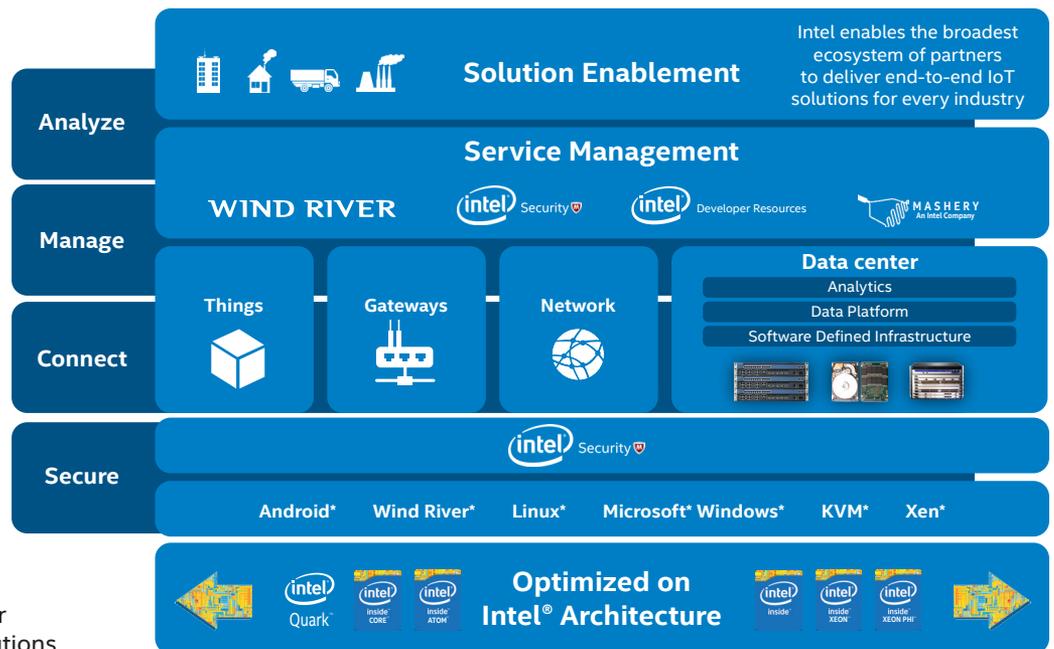


Figure 4. Intel Building Blocks for Trust and Intelligence in IoT Solutions

variety of systems. Central to the framework are 'things,' gateways, and network and data center infrastructure, for which Intel provides an array of building blocks, including:

Devices and Gateways

Complete Gateways

- [Intel® Gateway Solutions for the Internet of Things \(Intel® Gateway Solutions for the IoT\)](#) enable seamless and secure data flow between edge devices and the cloud.

Processors

- [Intel® Quark™ processor X1000](#) is a family of low-power, system-on-chips (SoCs) featuring a 32-bit, single-core, single-thread Intel® architecture-compatible CPU.
- [Intel® Atom™ processor E3800 product family](#) features enhanced media and graphics performance, error correcting code, industrial temperature range, built-in security, and integrated image signal processing.
- [Intel® Core™ processor product family](#) delivers exceptional CPU and media performance, along with enhanced security and I/O flexibility.

Software

- [Wind River* VxWorks*](#) is the world's leading commercial real-time operating system (RTOS) and has been serving the needs of embedded systems of all shapes and sizes for more than 30 years.
- [Wind River Linux*](#) is the leading commercial embedded Linux platform and the first to bring the advantages of open source without the risks to companies in all industries.
- [Wind River for Android*](#) offers a portfolio of software and testing products to support

rapid and high-quality platform and application development for devices running the Android operating system.

Network and Cloud Infrastructure

Processors

- [Intel® Xeon® processor E5-2600](#) is the first Intel® platform to offer solutions ranging from 18-core/single-socket up to 36-core/two-socket. When paired with the Intel® C604 or Intel® C602-J chipset, single or dual-socket configurations maintain compatibility with enterprise platform requirements.

Software

- [Carrier Grade Profile for Wind River Linux](#) is the first product to meet the registration requirements of the Linux Foundation's Carrier Grade Linux 5.0 specification built for a Yocto Project* Compatible product.
- [Intel® Datacenter Manager \(Intel® DCM\)](#) provides critical management capabilities for today's data centers. With the Intel DCM portfolio, IT and facility managers have the tools to improve manageability, increase availability, and reduce costs across key parameters, such as energy usage, monitoring, security, automation, and cloud.

Securing Data and Devices

[McAfee Embedded Control](#) maintains the integrity of devices, gateways, and servers by allowing only authorized code to run and only authorized changes to be made. It automatically creates a dynamic whitelist of the "authorized code" on the system. Once the whitelist is created and enabled, the system is locked down to the known good baseline and no program or code outside the authorized set can run.

Service Management

Intel acquired two companies, Aepona* and Mashery*, that have extensive API expertise. Their solutions enable independent software vendors (ISVs), network providers, enterprises, and OEMs to securely grant access to their network resources while making it easier to pursue monetization opportunities. Two of these solutions are:

- **Intel® Expressway API Manager (Intel® EAM)** is the first of its kind composite API platform designed to securely expose APIs to business partners and internal or external developer communities. API management capabilities include: developer on-boarding, API catalog and

lifecycle management, integration, routing, data protection, mobile-middleware, and AAA security.

- **Intel® Expressway Tokenization Broker (Intel® ETB)** is a hardware or software appliance designed to reduce the scope of payment card industry (PCI) and personally identifiable information (PII) data security standards. It provides format preserving data tokenization for any enterprise application tasked with handling clear-text primary account number (PAN) or sensitive PII data.

Solution Enablement

Intel is working with OEMs, ODMs, and systems integrators to bring complete, end-to-end solutions to market.

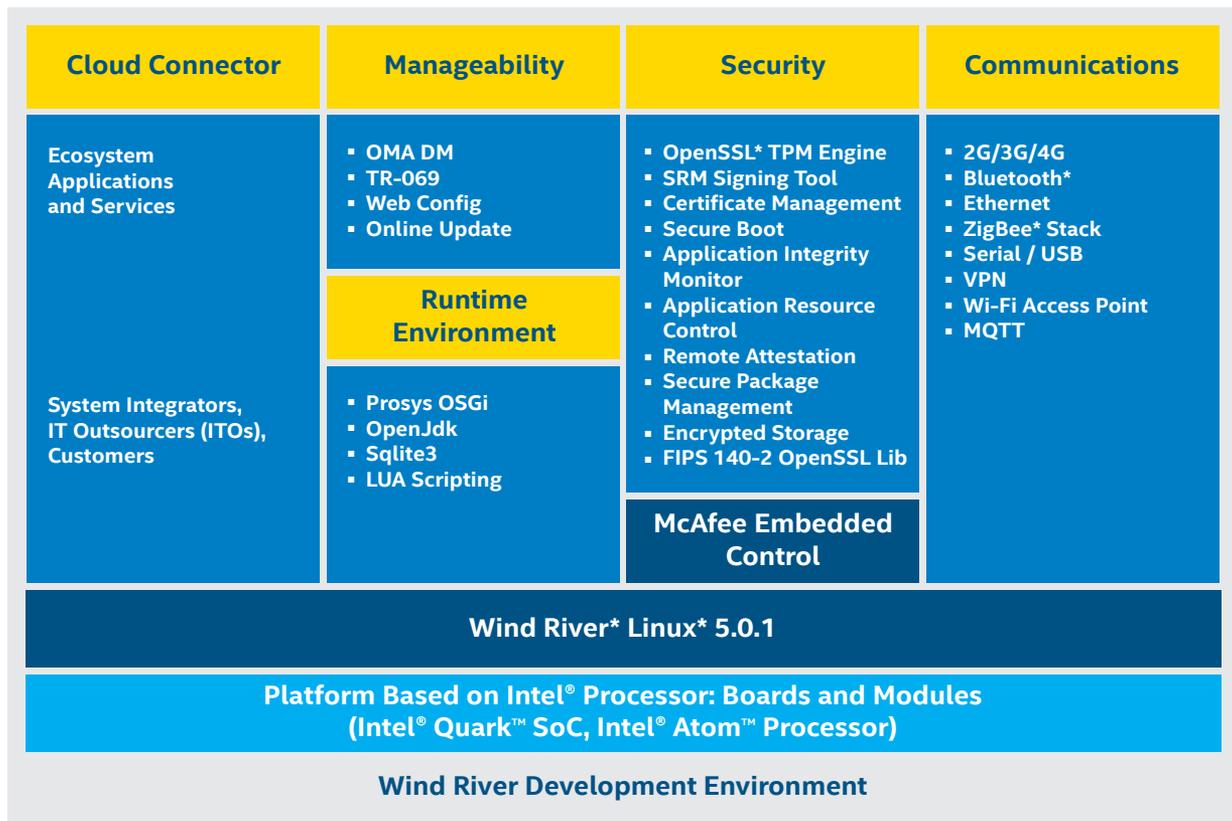


Figure 5. Intel® Gateway Solutions for the Internet of Things (Intel® Gateway Solutions for the IoT) Software Stack

Inside the Gateway

Intel Gateway Solutions for the IoT is built on open architecture to ensure interoperability between systems, facilitate wide application development, and simplify services deployment. The integrated and validated components shown in Figure 5 allow maximum flexibility, and fast application development and field deployment. The solutions offer complete, validated platforms consisting of hardware and software building blocks, including:

- Choice of Intel processors: Intel® Quark™ SoC X1000, Intel® Quark™ SoC X1020, and Intel® Atom™ processor E3826.
- Wind River Intelligent Device Platform* development environment.
- McAfee Embedded Control security technologies.

Developers can choose from a number of [development kits](#) featuring:

- Standards-based interfaces for I/O, cellular, and Wi-Fi simplify communications down to sensors and controllers and up to data centers and the cloud.
- McAfee Embedded Control maximizes security by dynamically monitoring and managing whitelists.
- Wind River Intelligent Device Platform* XT and Wind River Workbench* provide a proven development environment.
- Kits are complete with fully-configured compute board, wireless communications, security software, operating system, development tools, chassis, power supply, antennas, and documentation.

Intel also has an ecosystem of ODMs and systems integrators that provides solutions built from Intel development kits. Smart building solution

providers can use them to connect to existing and new sensors and systems in the building in order to control building systems and generate new insights into ways to improve power and energy management, etc.

Reducing the Cost of Smart Buildings

Operators and owners of small-medium sized buildings understand there are significant energy savings along with other benefits from building automation; but until recently, the necessary investment has been too great. Now, Intel and other providers of IoT technology are helping solution providers design building management systems at a fraction of the cost, which is expected to significantly expand the market. Intel is working with industry leaders to enable complete, secure solutions at lower cost than what is currently available. Developers can start prototyping and testing today using [Intel development kits](#).

For more information about Intel® solutions for smart buildings, visit <http://www.intel.com/iot/smartbuilding>

¹ Dan Probst, "The Business Case for Smart Building Technology, Oct 8, 2013, www.greentechmedia.com/articles/read/the-business-case-for-smart-building-technology.

² "Buildings Energy Data Book, Chapter 3: Commercial Sector," U.S. Department of Energy, <http://buildingsdatabook.eren.doe.gov/ChapterIntro3.aspx>.

³ "Integrated Building Management System (IBMS)," energy.gov, <http://energy.gov/eere/buildings/integrated-building-management-system-ibms>.

⁴ "Energy Efficiency in Local Government Operations," U.S. Environmental Protection Agency, 2011, pg 3, http://www.epa.gov/slclimat/documents/pdf/ee_municipal_operations.pdf.

⁵ Based on IoT gateways being approximately 10 times less expensive than proprietary gateways.

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Printed in USA MS/VC/1114 Order No. 331517-001US