Affordable Building Automation System Enabled by the Internet of Things (IoT)

HCL Technologies* uses an Intel-based intelligent gateway to deliver a powerful, yet cost-effective building management solution for small to medium-sized buildings.

Executive Summary

Building managers face growing pressure to reduce energy consumption and increase operational efficiency in order to boost the bottom line. Making this difficult, many buildings have disparate systems that must be controlled independently due to a lack of integrated building automation. For instance, it is not uncommon for companies to have various types of heating, ventilation, and air conditioning (HVAC) systems and security systems across their locations or even in the same building.

These issues can be addressed by deploying a building automation system (BAS); however, the high cost of such solutions has traditionally been difficult to justify for small to medium-sized buildings. This is now changing as leading edge technologies for the “Internet of Things” (IoT) are being used to drive down BAS cost and change the market dynamics for building management. This solution blueprint describes a cost-effective BAS solution from HCL Technologies* that delivers energy savings and productivity gains in all types of commercial buildings, including retail stores, factories, and corporate office spaces. The solution gives building managers full flexibility and keeps structure alterations to a minimum.
Key Business Objectives
Reduce facilities operating costs with the ability to monitor multiple building systems and properties at once, and optimize fine-tune building performance to a degree not possible via human capabilities alone.¹

Business Challenge
There are BAS solutions on the market today that allow multiple building systems to be managed through a single web site portal; however, they can cost hundreds of thousands, even millions, of dollars (USD), making them too expensive for operators and owners of small to medium-sized buildings. The high price tag is partly due to the closed, custom, and proprietary nature of these systems, which also gives the original equipment manufacturer full control over installations and upgrades.

Solution Benefits
The BAS from HCL is an integrated IoT solution that delivers clear advantages:

• Reduced Price Point: A low cost alternative to proprietary BAS solutions is to instrument a building using IoT technologies, such as low-cost wireless sensors, on-premises gateways, and cloud analytics. Instrumentation involves installing an independent network of actuators and sensors (e.g., temperature, light) throughout a building, thus eliminating the need to retrofit existing equipment.

• Lower Operating Costs: A centralized portal provides building managers with the analytic tools needed to increase energy efficiency and productivity through advanced data gathering and analysis, comprehensive reports, system-wide alarm management, etc.

• Minimal Infrastructure Changes: Since the HCL solution can be implemented with wireless sensors and actuators that only need power, which is often already available in the vicinity, infrastructure modifications can be minimal. The use of wireless sensors can reduce deployment cost by around 30 percent,² while at the same time increasing installation flexibility.

• Ease of Use: The intuitive interface enables building managers to visualize building data, thus facilitating fast and precise decision making. In addition, building managers can receive important building alerts and notifications on their wearable devices, like a smartwatch.

Solution Overview
IoT is enabling billions of Internet-connected devices, ranging from building sensors to simple pedometers. While the traditional Internet is based on an open architecture that invites broad developer participation, IoT extends the reach to include any electronic device. This openness creates an environment that fosters a rich ecosystem and reduced costs through economies of scale.

Bringing the power of IoT to building automation, HCL Technologies is able to dramatically reduce BAS cost for its clients. Solutions can be tailored to meet the specific requirements of different types of commercial buildings given HCL’s partnerships with a wide variety of sensor manufacturers. HCL is a global company that solves complex business problems by combining IT and engineering services expertise under one roof.
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Key Components
Figure 1 shows the main ingredients of a BAS solution consisting of:

- Sensors and actuators
- User interface devices
- Intel® IoT Gateway
- HCL building automation system software runs on gateways and/or in the cloud

Solution Capabilities
HCL’s BAS solution provides a range of powerful features to monitor building edge-devices and systems, including HVAC, security, lighting, water, hydraulics, and electrical equipment. All these features are designed for optimal energy efficiency and cost effectiveness, and can be integrated into new and existing mechanical and electrical equipment. The BAS solution controls various security and surveillance solutions, like CCTVs, access control devices, fire safety etc., and thereby provides full control of all disparate systems of the building.

Example Use Models
There are four main building automation use cases that are detailed in the following sections:

1. Core Automation and Control Features facilitate the automation/control, operation, maintenance, and management of building systems, including HVAC, safety and intrusion alarms, access control, and lighting (Figure 2). The features improve building comfort level, economics, security, and safety.

   Operations features simplify building system management
   - Single interface for managing multiple systems

2. Energy Consumption Analysis helps building managers identify trends that can drive more efficient energy usage. For instance, HCL BAS software can monitor the real-time energy consumption of an HVAC, compare it against predicted usage, and provide the results visually. The predicted usage trend is based on complex logic, which takes into account parameters like usage history, average ambient temperature, etc. When the actual energy consumption deviates from the expected, it is possible to trigger a preconfigured action, such as alerting the building

   - HVAC control, including operation modes and temperature set points
   - Remote control and monitoring from mobile devices (e.g., tablets and smartwatches)
   - Real-time remote monitoring of video surveillance
     > alerts when motion detected by cameras
   - Integration with smoke, noise, temperature, and humidity sensors
     > alerts when actual values exceed defined threshold values.
   - Alarm configuration: activate, deactivate, and reset alarms
   - Data visualization

Management features drive consistent building system performance
- Preconfigured settings for the configuration and execution of systems
- Scheduler functionality to automatically switch systems on/off
- Trend logs
- Cost allocation analysis
- Global strategy implementation

Figure 1. Building Automation System (BAS) Configuration Example

Figure 2. Core Building Automation and Control Features
manager. Additionally, the trend analysis module is integrated with a recommendation engine that suggests possible reasons for an alert and what actions should be taken in order to correct the observed deviation. The suggestions are accessible by selecting the alert symbols (!) shown in Figure 3. The graphs also indicate energy charges by time of day, allowing the building manager to schedule building system operation during off-peak times, thus minimizing energy costs.

3. Occupant Comfort Level Tracking enables building managers to continuously monitor the comfort level of building occupants and have preconfigured actions triggered when key parameters fall outside a predefined range. Comfort level parameters include temperature, humidity, noise, and light intensity level. Figure 4 shows a sample screenshot of comfort level trends.

4. People Proximity Sensing measures the density of people in a particular location and can take action based on predefined rules. People presence is detected by RFID tags in mobile devices carried by building occupants or embedded inside their wearable devices. These tags are read by different readers, which are located in various locations within the building, primarily at entry and exit gates. After counting the number of people in different areas of the building, the solution creates a people density heat map that identifies high traffic areas, as shown in Figure 5. This feature is particularly useful in retail since it measures number of customers visiting different regions in a store (i.e., footfalls).

When the number of people in a particular area exceeds a defined threshold range, it is possible to take action based on preconfigured rules. Some examples include:

- Switch on the air conditioning
- Reset the set point on the thermostat
- Play targeted promotions on digital signage display terminals
- Stock popular products in congested regions

**Technology**

**Sensors and Actuators**

Building owners and operators can choose from an assortment of sensors and actuators offered by vendor partners of HCL. These devices have been validated to ensure their compatibility and interoperability with HCL building solutions.

**User Interface Devices**

Building managers can use a variety PCs, tablets, and smartwatches to interface to HCL BAS solutions.
Intel® IoT Gateway

The Intel IoT Gateway offers companies a key building block to enable the connectivity of legacy as well as new building systems. It integrates technologies and protocols for networking, embedded control, enterprise-grade security, and easy manageability on which application-specific software can run.

The Intel IoT Gateway (Figure 6) enables:

• Connectivity up to the cloud and enterprises
• Connectivity down to sensors and existing controllers embedded in the system
• Pre-process filtering of selected data for delivery
• Local decision making, enabling easy connectivity to legacy systems
• A hardware root of trust, data encryption, and software lockdown for security
• Local computing for in-device analytics

In an HCL solution, the gateway communicates with building sensors and actuators, and collects event data on an as-needed basis or at specific intervals. It can also execute BAS data analytics and host web pages that provide a user interface for building managers.

The Intel IoT Gateway has several performance SKUs, providing HCL customers a solution that scales from one to multiple buildings. The gateway is support by a comprehensive software stack, Wind River® Linux® operating system, and hardware- and software-based security features.

HCL Building Automation System Software

HCL BAS software performs the automation, control, monitoring, and analytics functions previously described. With its advanced alarm management and extensive data gathering and analysis, building manager can remotely control and monitor appliances, like lights, load controllers etc., from their mobile devices. Real-time remote monitoring of video surveillance can also trigger an alert when motion is detected by cameras. The software is designed to deliver very high levels of stability, reliability, and scalability when running solely on Intel IoT Gateway or with portions running in the cloud for larger deployments.

IoT Tenets

The HCL building automation system is designed to provide security and interoperability from edge to cloud in keeping with five key tenets defined by Intel:

• World-class security as the foundation
  - The solution implements robust hardware and software-level protection that secures data from building systems to gateway to cloud.

• Automated discovery and provisioning of edge devices to ease deployment
  - HCL and its partners ensure select sensors and actuators operate in Plug and Play fashion with HCL BAS software.

• Data normalization through protocol abstraction to improve interoperability
  - HCL software performs protocol translation (e.g., ZigBee®, Ethernet, Wi-Fi) without building manager intervention.
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- **Broad analytics infrastructure** from edge to cloud to realize customer value
  - HCL software running on gateways and servers analyzes building data, generates actionable data, and creates easy-to-read reports.

- **Infrastructure** to monetize hardware, software, and data management from edge to cloud
  - The HCL solution enables building owners and operators to realize substantial savings though reduced energy consumption and increased operations efficiency.

**Summary**
The vast majority of small to medium-sized buildings are not equipped with building automation systems (BAS), mostly because solutions have been too expensive. As a result, facility operating costs are significantly higher than they need to be. The Internet of Things (IoT) is changing this paradigm by enabling powerful solutions that make existing buildings or new construction much more efficient and economical to operate. Taking advantage of IoT technologies from Intel, HCL developed a flexible BAS capable of driving innovative solutions in building automation, such as sending alerts to a building manager’s smartwatch or other mobile device.

**Resources**
**Intel® Internet of Things Solutions Alliance**
Members of the Intel® Internet of Things Solutions Alliance provide the hardware, software, firmware, tools, and systems integration that developers need to take a leading role in IoT.

**Intel® IoT Gateway Development Kits**
Intel IoT Gateway development kits enable solution providers to quickly develop, prototype, and deploy intelligent gateways. Available for purchase from several vendors, the kits also maintain interoperability between new intelligent infrastructure and legacy systems, including sensors and data center servers.


HCL Technologies is a member of the Intel® Internet of Things Solutions Alliance. From modular components to market-ready systems, Intel and the 250+ global member companies of the Alliance provide scalable, interoperable solutions that accelerate deployment of intelligent devices and end-to-end analytics. Close collaboration with Intel and each other enables Alliance members to innovate with the latest technologies, helping developers deliver first-in-market solutions.