



Controlling Office Temperature with Building Robotics

An environmental management solution empowers building occupants

“Comfy is about making people comfortable and connecting people with their physical environment by giving them more control.”

Andrew Krioukov
Cofounder and CEO
Building Robotics

Addressing Office Environment Management

All of us have seen it—a colleague using a space heater or blanket for warmth, while just a few feet away, you sit sweating with a fan on. Office environment temperatures are difficult to regulate and impacted by multiple factors, including the number of occupants, heat sources, windows, and the amount of sunlight reaching those windows. As a result, many office environments are not well served by their existing heating, ventilating, and air conditioning (HVAC) systems, resulting in an inefficient use of energy, as well as increased operational costs from dealing with occupant complaints and lost productivity.

Giving occupants control over the office environment increases comfort and satisfaction, as well as the efficiency of building heating and cooling systems. This may seem counterintuitive—but people are the best sensors for perceived comfort, an element that can be missing from systems available today, even with fully integrated temperature, humidity, and occupancy sensors. Often, occupant comfort is reached by doing less, not more, conditioning of air in a space.

Building Robotics' Comfy* is an application where building occupants can make individual requests for warm or cold air based on their comfort needs via a smartphone or desktop. The Intel®-enabled Building Robotics Gateway* physically connects the building management system (BMS) to the cloud. Then, Comfy aggregates data from the BMS and occupant requests and leverages machine intelligence to moderate and optimize building temperatures.

Balancing Energy Usage and Productivity

The thermal comfort of office employees can significantly impact their productivity¹. Complaints and discomfort not only contribute to lost productivity, they also require building managers to spend money and time solving each request. As a result, managers hoping to reduce energy costs by standardizing temperature across the building may find that they actually end up paying more due to increased operational costs from responding to occupant complaints.

Building owners and managers need secure, easily deployable solutions that have a positive impact on occupant experience and the bottom line. Furthermore, greater customization is especially vital in multi-tenant buildings, which often support diverse workplace patterns and designs within a single building.

Configuring Flexible Temperature Controls

Existing HVAC systems in office buildings have multiple, predefined zones based on existing ventilation ducts and equipment. Temperatures are typically configured in these zones according to lease and space requirements. These requirements are often not in sync with occupant comfort, which results in over- or under-conditioning of the air in a space. This leads to an experience most people who have worked in an office environment can relate to—an office that is persistently too hot or too cold.

Comfy digitally connects existing HVAC systems in buildings to the cloud through an Intel-based gateway running Ubuntu*, a leading open source operating system. In the cloud, Comfy integrates both human interaction and machine intelligence to optimize building systems. Users can access the Comfy app or web page to request hot or cool air for a specific building temperature zone. Comfy receives the request and automatically provides 10 minutes of heated or cooled air in order to quickly respond to occupant discomfort. The solution learns from user requests, identifying patterns and preferences based on location and time of day, and adjusts the temperature accordingly.

In addition, by providing users with a simple interface displaying requests in their area and a summary of their personal preferences in relation to the preferences of their neighbors, Comfy offers a new level of transparency into office temperature, and effectively mitigates most temperature conflicts before they even begin. With Comfy, 97 percent of people in the same zone agree on temperature settings.

Designed for Commercial Environments

Comfy is a software solution designed to manage temperature zones in commercial real estate, and yields the best results in environments where the HVAC system utilizes forced air or fast-response systems. The simplest integrations are for variable air volume (VAV) systems managed with direct digital control (DDC).

Designed as a software-as-a-service (SaaS) solution, Comfy is customizable to a single area or floor within a building, or expandable to an entire building or campus of buildings. Employees of companies with buildings in multiple locations can access Comfy through the same interface when visiting other locations.

Comfy is quick to implement and secure, and provides flexibility for building occupants. Because Comfy communicates with the BACnet industry standard, it is easy to deploy across a majority of large commercial buildings (approximately 70 percent of buildings over 100,000 square feet).²

Comfy* dynamically adjusts temperature set points and ranges according to occupant preferences.

UP TO 25% ENERGY SAVINGS³

Successful implementations of Comfy include office spaces for AppNexus, Google, Johnson Controls, The Swig Company, General Services Administration, Glumac, University of California Berkeley, Salesforce, and Infosys.

Comfy advantages for building occupants, managers, and owners include:

- **Improve Building Occupant Comfort:** Human interaction and machine intelligence are combined to establish the appropriate temperature for a comfortable office environment.
- **Reduce Temperature Complaints:** Occupants are empowered with control over the temperature in their environment.
- **Improve Energy Efficiency:** Comfy dynamically adjusts temperature set points and ranges according to occupant preferences, rather than maintaining zone temperatures at preconfigured levels. Comfy also reduces air conditioning when office spaces are unoccupied. Typical energy savings are between 15 and 25 percent of HVAC energy.³
- **Identify Malfunctioning Equipment:** Implementing the Comfy solution in a building can help identify existing problems in building HVAC systems, including:
 - Broken equipment, such as thermostats, discharge air sensors, or air flow sensors
 - Zones where VAV capacity is inaccurate, due to changes in the number of people in a space or the number of heat sources
 - Situations where overcooling triggers overheating, so the HVAC system is constantly cycling
- **Effective Service Calls:** Temperature-related service calls are focused on real issues, rather than simply on comfort levels.

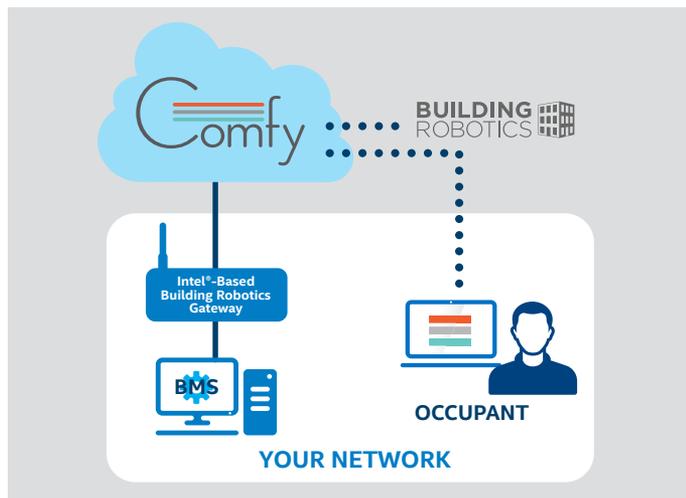


Figure 1. Comfy* solution architecture

How It Works

The architecture shown in Figure 1 illustrates the simplicity of the Comfy solution.

1. Building Robotics assists in system analysis prior to deployment.
2. A single piece of hardware, an Intel-based Building Robotics Gateway, connects the BMS to the cloud.
3. This information is integrated into a customized Comfy instance in the Comfy cloud.
4. The Intel-based Building Robotics Gateway is installed at the building site.

Solutions are customized by Building Robotics, based on the following:

- Building mechanical systems information, including drawings with HVAC systems and zoning
- BMS type and characteristics, including control points and confirmation the BMS is BACnet-enabled
- Floor plans for selected service areas
- Networked access to the BMS and outgoing Internet connectivity via Ethernet or cellular link

Building Robotics Gateway

The gateway is powered with a dual-core Intel® Atom™ processor E3826 and communicates with the BMS and the cloud via Ethernet or cellular link. This enables Building Robotics to focus on the software stack, based on Ubuntu, supporting the Comfy experience.

Building Robotics Gateway functions include:

- Linking wide area network (WAN) and local area network (LAN) technologies
- Encrypting cloud communications
- Synchronizing BMS data with the cloud
- Supporting instant remote access and real-time notifications
- Providing autonomous operation when a WAN link is unavailable

The gateway also supports Building Robotics Trendr*, which collects building data and provides management reporting.

SNAPPY UBUNTU CORE*

Snappy Ubuntu Core* is specifically designed for IoT applications such as Comfy*. It is fast, reliable, and has strong security that prevents tampering.

Key attributes of Snappy include:

- Ubuntu distribution is ultralightweight
- OS and application files are read-only, which prevents tampering and allows for predictable updates
- System and application updates can be rolled back
- Signatures and fingerprints ensure what's running is exactly what was published by the developer

Comfy Cloud

In the Comfy cloud, user data informs a complex machine-learning algorithm that also tracks inside and outside temperature, user location, and historical requests for the zone. The algorithm is designed to manage building temperatures to satisfy the most occupants in a single zone. The algorithm tunes the BMS to demand. It sets ranges, which reduce energy consumption, while still maintaining occupant comfort.

Comfy Integrated APIs

Comfy leverages third-party APIs for weather data, as well as Android* and iOS* GPS data. This data contributes to the Comfy machine-learning algorithms.

Comfy Monitoring Interface

A monitoring interface provides real-time information on system and user activity and management and facilities reporting. Through the interface, small adjustments may be made in order to customize float ranges for temperature in specific zones.

Comfy Web Interface and App

Building occupants access Comfy via a Web interface or the Comfy app.

Comfy Security

Security is embedded throughout Comfy to provide a scalable, reliable, and secure solution.

System Security

The Building Robotics Gateway encrypts data on disk and takes advantage of Intel hardware-level security. Each gateway is locked down to limit modifications to requests for warm or cool air.

Between the gateway and the cloud, two-sided Transport Layer Security (TLS) encryption is used. The cloud is hosted on an Amazon AWS* server with firewalls and redundancy to protect building data. Security updates to the cloud solution are applied regularly and pushed to the gateway.

Comfy uses only outbound connections; therefore, no ports are opened in corporate firewalls. Internet access is supported through an HTTP proxy server.

User Security

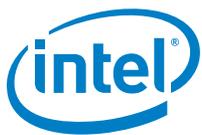
A corporate email is required to register for Comfy. Single sign-on (SSO) and active directory may be used for secure access. Each user session generates a unique session token which is verified per transaction.

Increasing Building Automation

Building Robotics Comfy utilizes Intel® IoT technologies to generate value and reduce costs. It offers an example of the potential for buildings to increase occupant comfort based on connected, data-rich technology solutions.

For more information about Building Robotics solutions for building automation, visit BuildingRobotics.com.

To learn more about Intel solutions for smart buildings, visit intel.com/iot/smartbuilding.



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