Exploring HVAC and Lighting Controls Integration and Interoperability: mwConnect Creates a Demonstration Showcase

In 2024 mwConnect, an industry-leading provider of Bluetooth® wireless mesh lighting controls, committed to explore the possibilities of integrating lighting control with HVAC by creating a testbed in its Sacramento headquarters. The company built a unique showcase for market stakeholders by upgrading its lighting systems, deploying wireless mesh networked lighting controls (NLC), and integrating the facility's HVAC control with the new NLC controls.

Background

The goal for the project team was to transition existing control zones, used for proof of concept and mesh testing primarily, to create defined mesh systems each showcasing advanced controls with HVAC integration.

CBECS, a national survey[1] that collects information on the stock of U.S. commercial buildings (including their energy-related building characteristics and energy consumption data), classifies most small- and medium-sized business facilities as being under 25,000 feet^2 in size, and accounting for 30% of all commercial buildings. The mwConnect offices cover 10,000 feet^2, with another 15,000 feet^2 dedicated to production and warehousing. The Sacramento, CA. location houses 30 employees working primarily five days a week, 8 am-5 pm schedules performing administrative and engineering tasks. Prior to the retrofit, the site used a variety of light sources, including fluorescent, LED, CFL, halogen, and incandescent lighting. Localized groups of mesh-controlled lighting from earlier proof of concept projects existed, as well as standalone PIR occupancy sensors, and standalone wall switches. The team, led by Executive Vice President Stephen Zhou, proposed laying out 88 lighting fixtures, embedded with DALI D4i drivers and D4i wireless sensor controllers, and six HVAC units into three identifiable mesh networks with each network using to its own separate gateway. This would facilitate the team's ability to measure separately specific issues (i.e., drop off and latency) for each mesh network at scale.

Designing the Project

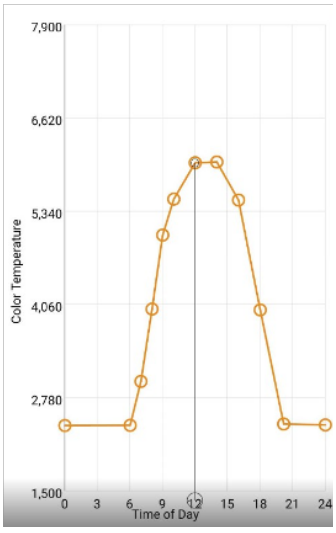
The team set up multiple strategies to control the space. Tunable white, circadian lighting, dimming, high end trimming, scheduling, daylight harvesting, occupancy/vacancy sensing, and power metering were all incorporated. Using Signify and Osram DALI D4i drivers, the LED luminaires featured combinations of single channel driver plus wireless controller, and dual channel tunable white drivers plus wireless controllers. Showcasing human-centric lighting was important, so a large conference room was selected for implementation.

The team developed a different strategy to include integrated HVAC control to the project. Using WIFI, the team leveraged the use of set-points in integrating with the lighting control mesh networks.

One mesh network utilized the mwConnect TruBlu Bluetooth NLC protocol, comprised of forty-four fixtures in private offices, break room, foyer, and open floor plan areas. Each luminaire incorporated wireless mesh sensor-controllers (PSC-ZBD-I-11N-BLE-SR) for luminaire level lighting control. Certain offices and common areas were also outfitted with wireless kinetic wall switches that require no wiring or batteries. Using high-end trim (to 70% output) and an occupied dimming level of 55%, significant energy savings were realized, often exceeding 60% (approximately 30 watts per fixture beyond the 46 watts per fixture attributable to the fluorescent to LED conversion). In the breakroom, which often doubles as an impromptu meeting room, the team used a 4-button wall switch to facilitate scene control in that space. With large plate glass windows along the perimeter wall, the space was ideal for multiple zones. The project team decided to create 4 zones: two zones specifically for daylighting plus occupancy, and two for occupancy alone.

The team designed a second mesh network using the Casambi protocol. For this network, the team deployed forty-four fixtures across a large conference room, private offices, an open office area, library, server room, print center, and a transition area to a warehouse production area. Project participants replaced the original troffers (fixtures using three F32T8 lamps or three-lamp F28T5 fixtures) with 50w 2x4 LED fixtures, and incorporated wireless mesh sensor-controllers (PSC-ZBD-I-11N-BLE-CB). In specific spaces, the team decided to deploy fixture-integrated WCM-200 controllers instead of sensor-controllers. By installing a 4-button wall controller and dual channel wireless controller, occupants in an engineering office without windows could adjust the new tunable white fixtures for their comfort. By enabling access of the tunable white fixtures in the large conference room with the scheduling features of the Casambi APP, the design team created a circadian profile developed specifically for the office's west coast location. Activating at 6 am with a 2400K CCT, the system gradually cools the CCT spectrum to 6000K CCT through mid-afternoon when the control profile ramps back to the warm 2400K until 8 PM when the network executes an automatic shut-off (see images below). The control scenario for this large conference room also leverages occupancy sensing and daylight harvesting to maximize energy savings.

Time of Day	Color Temperature
6:00 AM	2400 K
7:00 AM	3000 K
8:00 AM	4000 K
9:00 AM	5000 K
10:00AM	5500 K
12:00 PM	6000 K
2:00PM	6000 K
4:00PM	5500K
6:00PM	4000 K
8:00PM	2400K



Typical of most medium-sized commercial buildings of this early 2000s vintage (it was built in 2001), the original HVAC system used zoned Roof Top Units (RTU) and standalone hardwired thermostats. Of the five roof top units, one utilized two thermostats to control temperatures in a production area and a training room. The team replaced all the thermostats with wireless mesh enabled models and connected them to an edge gateway. Traditionally

Unit	Space	Occupancy Sensing (Business Hrs)	Business Hours Set-points (default un-occupied)	Occupancy Sensing (Non-business hrs)	Non-Business Hours Set points (default un-occupied)
HVAC #8	Server Room	24/7 @ 71◦	24/7 @ 71◦	24/7 @ 71◦	24/7 @ 71◦
HVAC #10	Lg. Conf. Rm, South Offices, Reception	H-71◦ / C-73◦	H-69◦ / C-75◦	H-71◦ / C-73◦	H-66◦ / C-78◦
HVAC #11	Open Area - Cubicles	H-71◦ / C-73◦	H-69◦ / C-75◦	H-71◦ / C-73◦	H-66◦ / C-78◦
HVAC #12	LAB	H-71◦ / C-73◦	H-69◦ / C-75◦	H-71◦ / C-73◦	H-66◦ / C-78◦
HVAC #13	Breakroom	H-71◦ / C-73◦	H-69◦ / C-75◦	H-71◦ / C-73◦	H-66◦ / C-78◦

the HVAC system might have “business hours” heat/cool settings, and “non-business hours” heat/cool settings. The Sequence of Operation was updated from this legacy “Set Point” approach with only weekday and weekend settings, to include operation using data from occupancy sensors. The team created a “cascade” set point program using this additional occupancy data to establish an operating range across an “Occupied/Business hours” and “Occupied/ Non-business hours” spectrum with higher heat and lower cool threshold settings. This narrower, more constant temperature range focuses on increasing occupant comfort. The team continues to log data from the occupancy sensors in an ongoing process to refine the time-of-day ranges in order to capture additional energy savings. Occupancy Based Controls (OBC) Studies[3] have shown weekly HVAC savings of 17-24% are possible.

In addition to the 88 new and retrofitted luminaires outfitted with DALI LED drivers, the project used 93 sensor-controllers and controllers, and 17 wall switches, streamlining the communications between luminaires and mesh devices.

Project Results

Layering multiple strategies, such as high-end trim plus setting a dim level, or leveraging occupancy data to refine the HVAC setpoints, accelerated energy savings, in some cases above 70%. For instance, operating the legacy lighting averaged 8280 watts. After the lighting and controls retrofit, the upgraded systems operated using 2588 watts, a 69% reduction. The 5722 watt reduction in operation calculated out to a -45kWh per day reduction and a -11,900 kWh reduction annually (using a typical 8/5 work schedule).

The total materials cost was less than $24,000 and included all gateways and thermostats. Total project costs, including labor, were just under $39,500. Estimated annual energy savings from lighting retrofits is $1,646. The site is currently running before and after metering readings to establish the net reduction from the additional 84 occupancy sensors.

Financial incentives that would be possible include potential rebates of $2,220.00 from the local electricity provider (Sacramento Municipal Utility District (SMUD), and potential tax credits of $15,750 (the 179D Commercial Buildings Energy Efficiency Tax Deduction[4] was updated in 2020, and such a building upgrade might qualify for tax credit treatment).

The fixture retrofit converting lights from fluorescent to LED, combined with the installation of occupancy sensors as a strategy alone, saves 8.3 metric tons of CO2 emissions each year.

Project Participants

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References

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