EMIS for Small Buildings: UC Davis Presents a Scalable Model for Remotely Controlling and Monitoring HVAC Systems

Presenters: Nico Fauchier-Magnan, Tom Ryan, Joshua Morejohn, & Nathan Cardoza, UC Davis
Moderator: Hannah Kramer, P.E., Lawrence Berkeley National Laboratory
December 16, 2021
Welcome!

With speakers from UC Davis | Facilities Energy & Engineering

Moderator: Hannah Kramer, Lead, Better Buildings' EMIS Tech Team LBNL

Nico Fauchier-Magnan, Energy Engineer Supervisor

Tom Ryan, Energy Project Manager

Joshua Morejohn, Energy Manager

Nathan Cardoza, Refrigeration Shop Supervisor
Small Workplace Automation & Remote Monitoring (SWARM):
A scalable model for remotely controlling and monitoring HVAC systems, designed & deployed at UC Davis

- What is SWARM?
- How does SWARM work?
- Buildings in SWARM at UC Davis
- SWARM for maintenance
- How to get SWARM started
Better Buildings Webinar
Dec 16, 2021

Small Workplace Automation & Remote Monitoring
What is SWARM?

Problem – Solution – Goals & Benefits – Savings at UC Davis
What is SWARM? – *Problem:*

- **Hundreds of small buildings** on campus with **stand-alone HVAC systems** that are not connected to the centralized HVAC scheduling system
- **Can result in poor comfort** when occupied
- **No remote visibility** into the HVAC system
- **HVAC often stays on** when unoccupied
What is SWARM? – Solution:

• **Connect** these isolated units to a secure network to allow for **remote** HVAC scheduling

• Create an **occupancy-based** schedule with help from the **building manager**

• Give HVAC monitoring information to the **facilities maintenance team for remote troubleshooting**
What is SWARM? – *Goals & Benefits:*

- **Improve the comfort** of occupants
  - Set schedules based around building occupancy
  - Give select users the ability to adjust schedules for *special events*
  - Ramp up conditioning hours before occupancy to reach set point on time

- **Improve maintenance** of HVAC equipment
  - Send out customizable *alerts* for equipment *issues and failures*
  - Remote *troubleshooting* of hot and cold calls using *temperature and equipment trend data*
  - Effective control & monitoring of economizers

- **Trim energy use** when building is not in use
  - Turn off HVAC systems on *holidays and weekends* for most buildings
  - Quantify *savings* using data from scheduling and set backs
**What is SWARM? – Savings at UC Davis**

<table>
<thead>
<tr>
<th>2,000+</th>
<th>900 MWh</th>
<th>$70,000/yr</th>
<th>$200,000</th>
<th>35%</th>
</tr>
</thead>
<tbody>
<tr>
<td>TONS OF HEATING &amp; COOLING CONTROLLED (120 buildings)</td>
<td>ANNUAL ENERGY SAVINGS</td>
<td>ANNUAL ENERGY COST SAVINGS (at 7.5 cts/kWh)</td>
<td>TOTAL INVESTMENT</td>
<td>PERCENT DECREASE IN HVAC EQUIPMENT RUNTIME</td>
</tr>
<tr>
<td>$150k</td>
<td>$70,000</td>
<td>$200,000</td>
<td>35%</td>
<td></td>
</tr>
</tbody>
</table>

(Would be ~$150k/yr at typical commercial rates)

**UC Davis**
Energy & Engineering
How Does SWARM Work?

Technology Examples – Building Level – Network Level – IT Requirements
How Does SWARM Work? – Example Technologies*

Examples of wireless enabled thermostats include:

- Pelican Wireless
- Honeywell BACnet FF
- Ecobee SmartBuildings
- JCI TEC3000
- Telkonet Touch / EcoInsight
- TCS Basys UbiquiStat
- 75F technologies

*Representative not comprehensive vendor examples
How Does SWARM Work? – At the Building Level

- Internet Programmable Thermostats
- HVAC Units
- Economizer Controllers (Optional)
- Gateway Ethernet Port

Wireless communication on different bandwidth than WiFi

To the Cloud

Conditioned Spaces

UC Davis Energy & Engineering
How Does SWARM Work? – At the Virtual Level

User

Thermostat Dashboard

Schedule Dashboard

History

Graphs

Private VLAN

To Building

History

Graphs

Office 101

Space Temperature

 UCDAVIS
Energy & Engineering
How Does SWARM Work? – IT Requirements

- **Security requirements** for UC Davis (your IT team may have different requirements):
  - Wired network connection for the **gateway**
  - Proxy server for the **gateway-to-web server** connection
  - Wireless mesh network (not Wi-Fi bandwidth) for **thermostat-to-gateway** connection
  - Thermostats can ping server to ask for changes (ie, outbound communications only)
  - Ability to set **static external IP address** for **gateways**
Buildings in SWARM at UC Davis

Current Buildings – IETCR Building Case Study
Buildings in SWARM at UC Davis

- Currently, there are **120 buildings** in SWARM at UC Davis
  - Total area: 440,000 sq. ft.
  - Largest: 28,000 sq. ft.
  - Smallest: 650 sq. ft.

- These include
  - temporary buildings
  - trailers
  - isolated labs
  - annexes
  - rooms within larger buildings
  - athletic facilities
Case Study: IETCR and Materials Management Office

- 25 tons of heating/cooling
- Existing electric meter
- Economizers on all units
- 20,000 sq. ft.
Case Study: IETCR and Materials Management Office

- Average Energy Use (kWh / day)
  - Before SWARM (2017)
  - After SWARM (2019)

- Daily Energy Usage (kWh/day)
  - Weekend & Holiday Setbacks
  - Better Scheduling & Set Points

- Annual savings of **120,000 kWh/year** and **$7,000/year**
  - **40% reduction** from the previous year
  - 2017 EUI = 39 kBTU/yr/ft².
  - 2019 EUI = 23 kBTU/yr/ft²
SWARM for Maintenance

Example of a success story: from alarm to repair, while keeping customers happy
SWARM Demonstration

Navigating the user interface for a sample manufacturer
How to Get SWARM Started

Identify Buildings – Select a Vendor – Get Buy-In
How to Get SWARM Started – *Identify Buildings*

- Good SWARM candidates are **small buildings** where connecting to the central BAS is not cost-effective.
- From that criterion, **identify a few pilot buildings** that fit most or all of these characteristics:
  - **Metered**, with access to one year of utility data
  - **Flexible** HVAC requirements (offices & classrooms are better than labs)
  - History of occupant **HVAC complaints**
How to Get SWARM Started – *Select a vendor*

• Key **considerations** when evaluating **different technologies** for SWARM:
  • Communications (WiFi, Zigbee, Ethernet...)
  • IT security requirements
  • User interface (scalability, schedules, alarms, trend data, etc)
  • Types of compatible HVAC systems (rooftop units, fan-coils, VRF, etc)
  • Occupant controllability
  • Maintenance capabilities (alarms, notifications, ease of initial setup)
How to Get SWARM Started – Get Buy-In

• Crucial to **discuss** SWARM process and networks **with IT team** at the outset
  • See **SWARM IT Team Module** for discussion of SWARM security, network, and technology

• Provide **in-person** presentation and **hands-on** training of SWARM for **HVAC maintenance team**
  • The more comfortable the HVAC team is with SWARM, the more effective the program will be
Questions?

- Hannah Kramer (hkramer@lbl.gov)
- UC Davis SWARM Team (swarm@ucdavis.edu)

Get involved:

- Building owners, operators, and managers: join the Better Buildings Alliance or contact bba@ee.doe.gov with questions
- Join the EMIS Tech Team list: send request to emis@lbl.gov

Better Building Solution Center Resources

*NEW* Low Carbon Technology Strategies Toolkit – (Link)

Smart Energy Analytics Campaign Toolkit (Link) with:
- Business Case Resources:
  - Final Report | Applications Showcase | Success Stories | EMIS Infographic
- Resources for getting started with EMIS:
  - Crash Course | Primer | Procurement Spec

Register for our next EMIS Webinar on March 10th: SCALING UP HVAC FAULT DETECTION IN A PORTFOLIO (Register Now)