Wireless Supervisory Controls for HVAC Energy Management

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FEDERSPIEL CONTROLS

Overview

- Wireless technology
- Wireless supervisory HVAC control
- Applications
  - CAV to VAV retrofits
  - Demand response
  - Data center cooling control

Wireless technologies

- Wireless voice/data systems
  - Cellular
  - Pagers
  - Modems

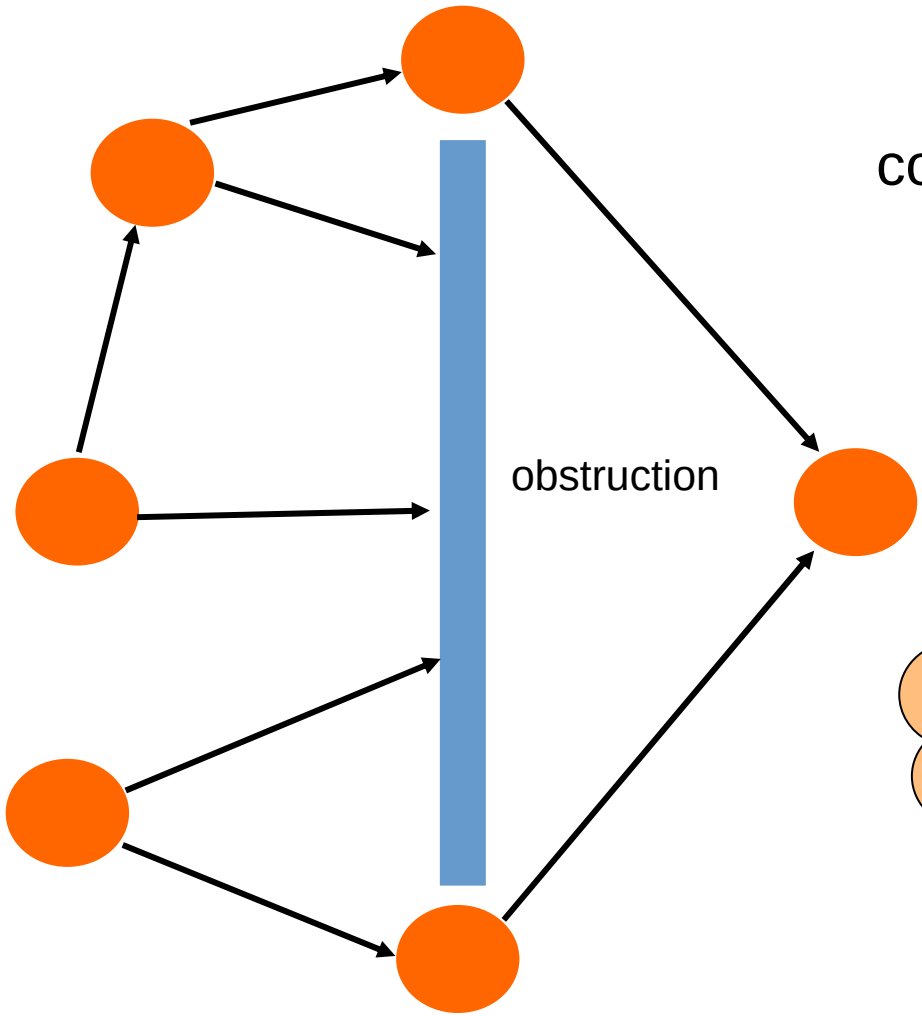
- Wireless LAN
  - 802.11 (a,b,g)
  - WiFi

- Wireless sensor networks
  - 802.15.4
  - Zigbee
  - Motes

Wireless sensor networks

- Industrial, Scientific, and Medical bands
  - 902-928 MHz
  - 2.4-2.4835 GHz
- Low power (1 mW typ)
- Spread spectrum
  - Frequency Hopping (FHSS)
  - Direct Sequence (DSSS)
- Standards
  - IEEE 802.15.4
  - Zigbee

Mesh networks

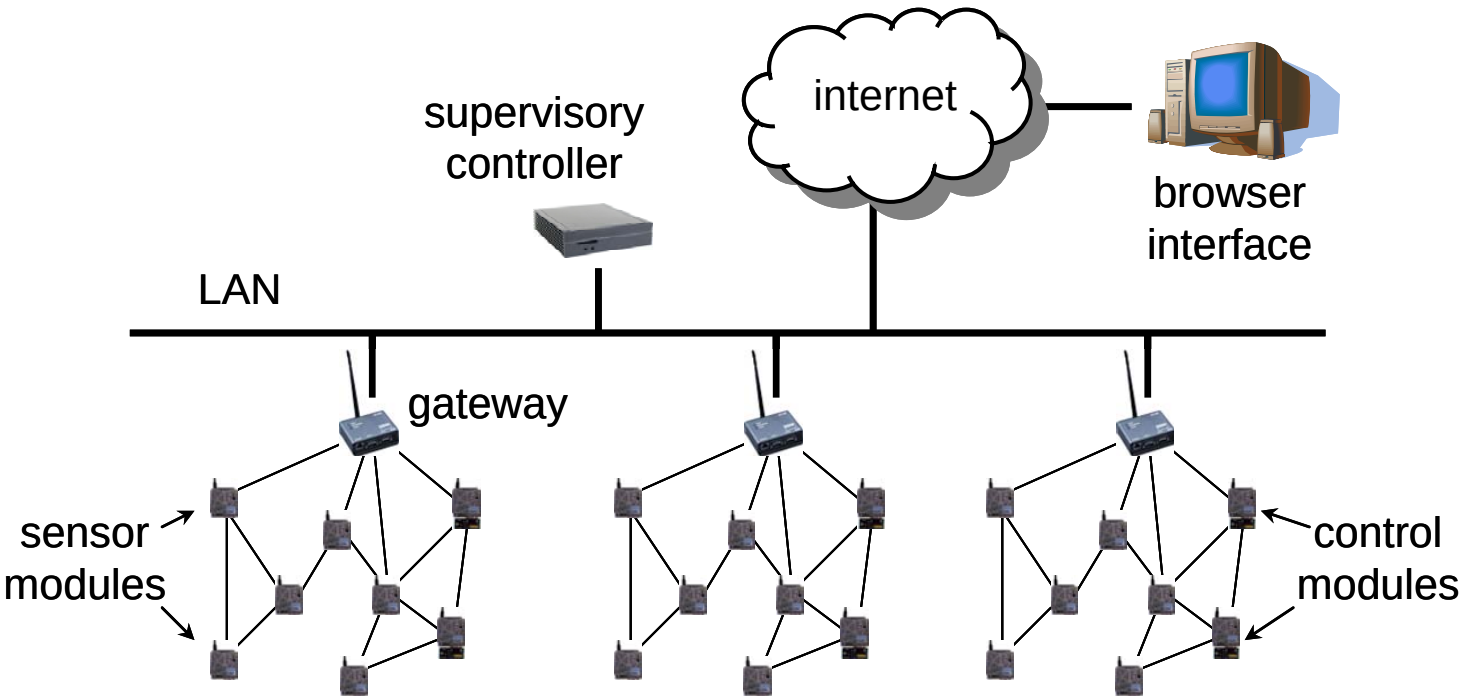


Point-to-point communications can be blocked

Mesh networks self-form and self-heal to route around obstructions

Wireless supervisory control system

- Wireless mesh networking I/O modules
- Analog interfacing (no protocol drivers)
- Web-based
- Supervisory control (energy)

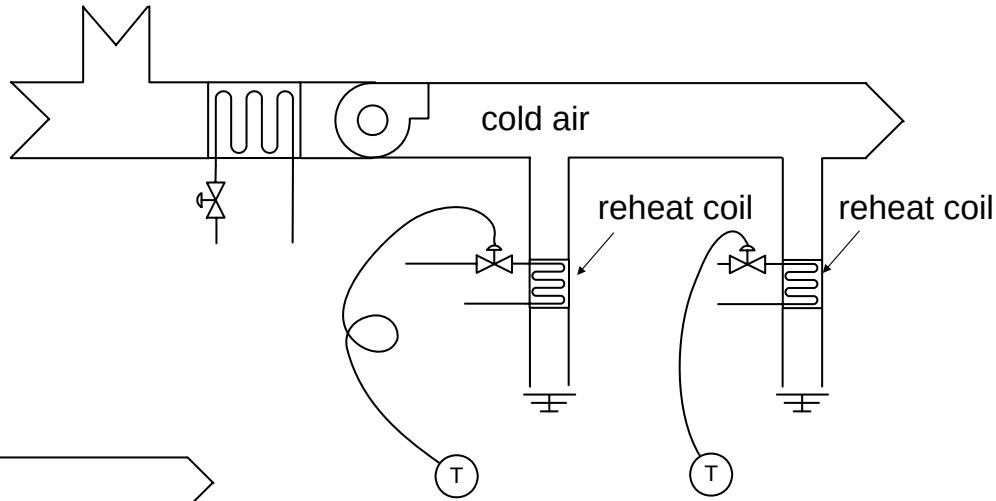


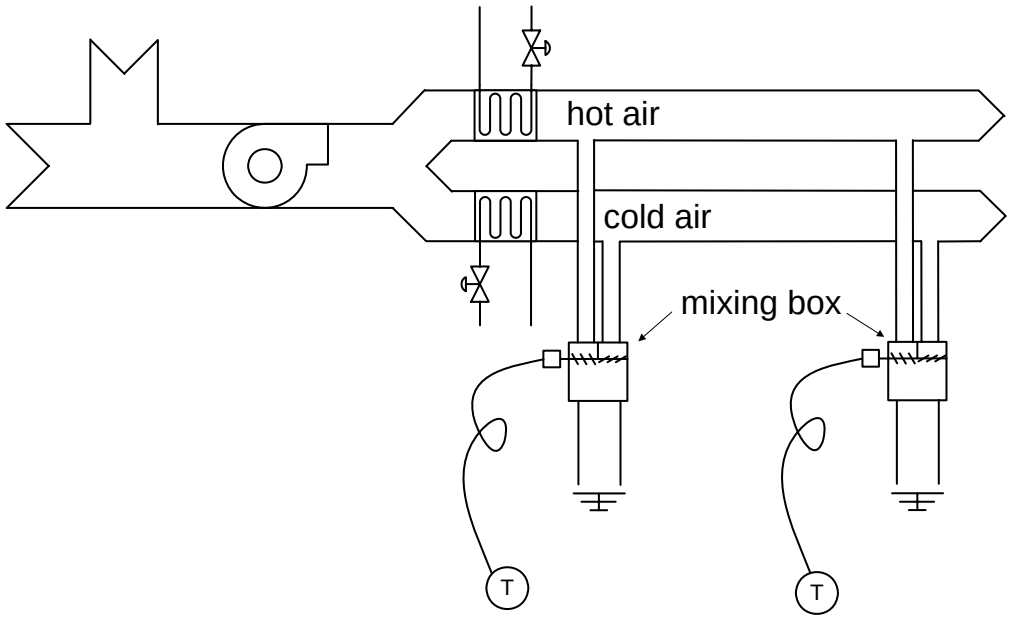
Energy management applications

- **CAV to VAV retrofits**
- Demand response
- Data center cooling control

Constant volume HVAC

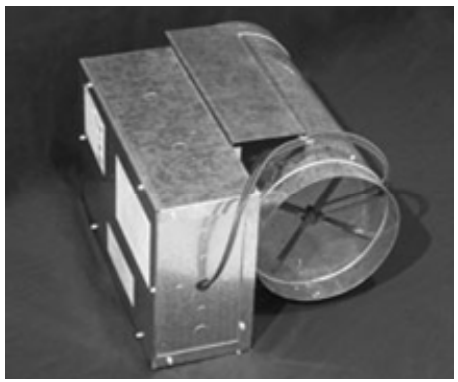
- Notoriously inefficient
- Expensive to retrofit

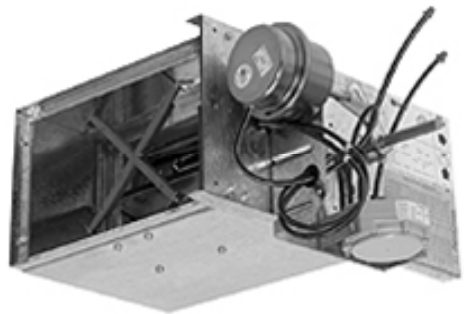




Conventional retrofit

- Terminal retrofits





- VAV diffusers

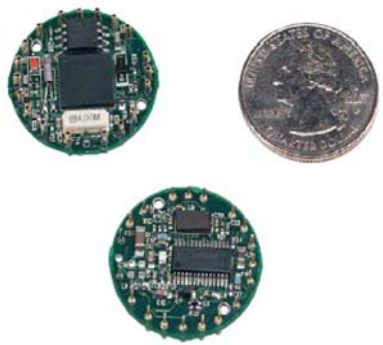


Other issues with conventional retrofits

- Occupants must move
- Asbestos abatement may be required

DART/FACS method

- Wireless sensors to measure discharge air temperatures
- Regulate highest or lowest with fan speed (need VFD)
- No mechanical retrofits
- No need to get above the ceiling
- Called Discharge Air Regulation Technique (DART)



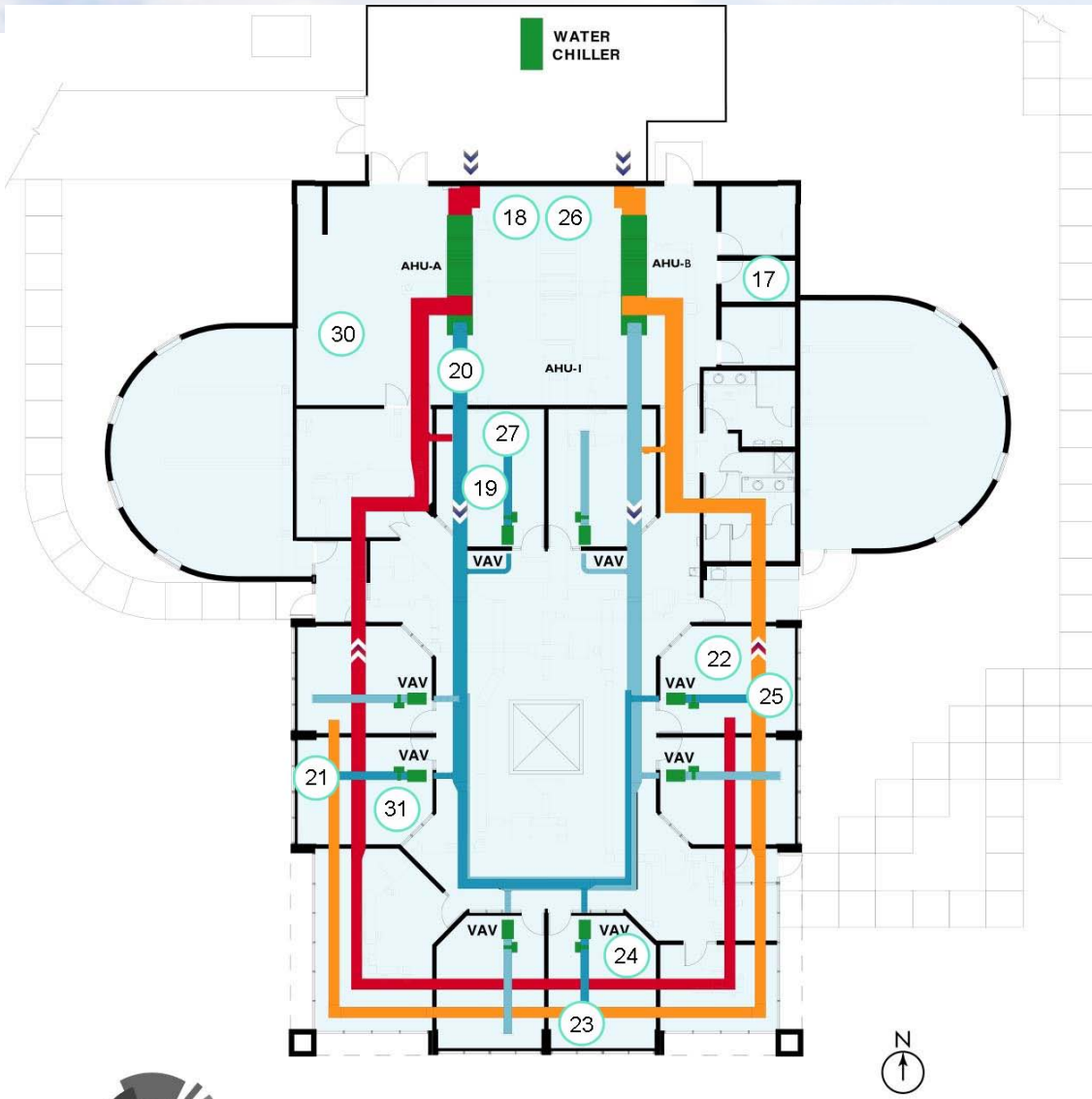
DART demonstration

- Iowa Energy Center's Energy Resource Station (ERS)
- PIER funded
- John House
- Martha Brook

pier
PUBLIC INTEREST ENERGY RESEARCH
"Research Powers the Future"

Side by side comparison

- Identical AHUs
- Two tests
- Submetered loads
  - Boilers
  - Chillers
  - Fans
  - Pumps
- ~800 sensor points
- Calibrated regularly

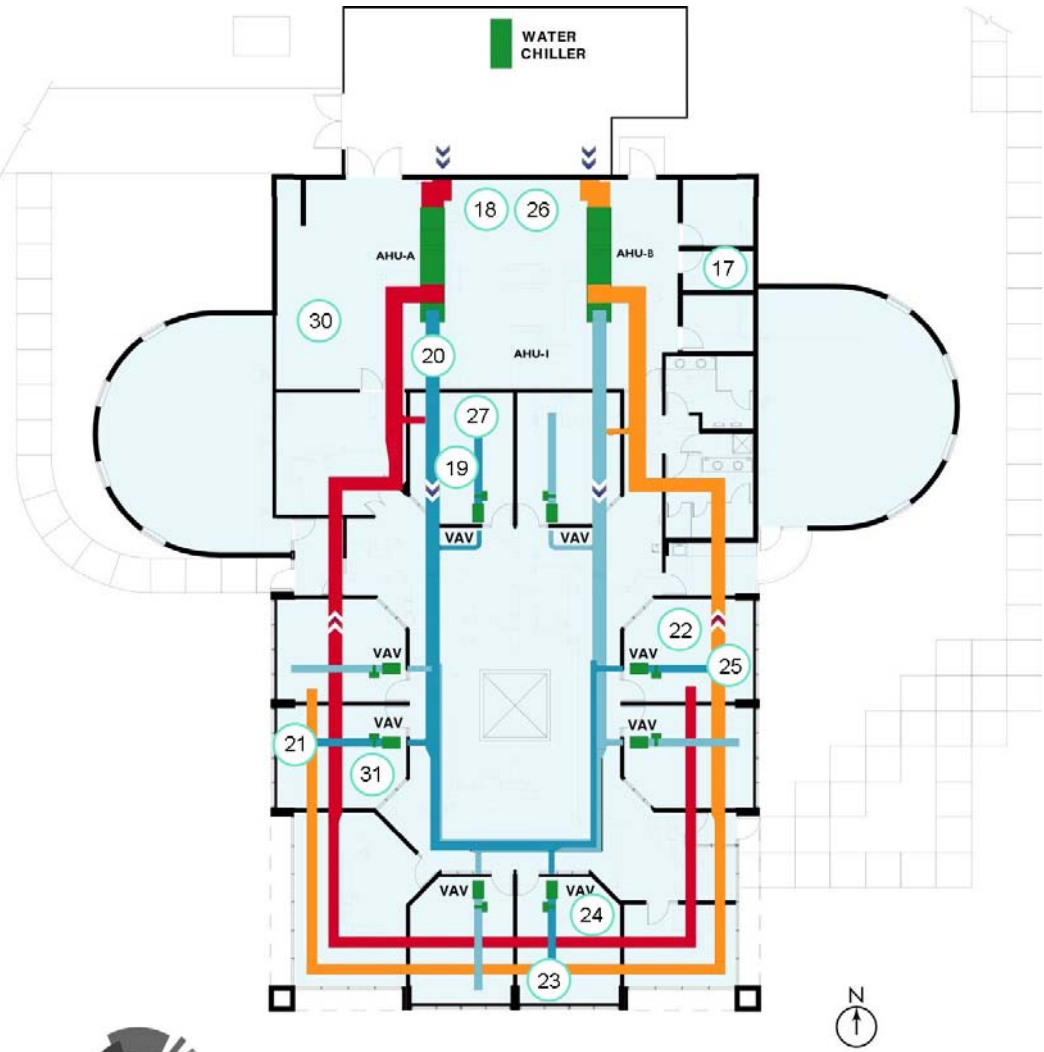


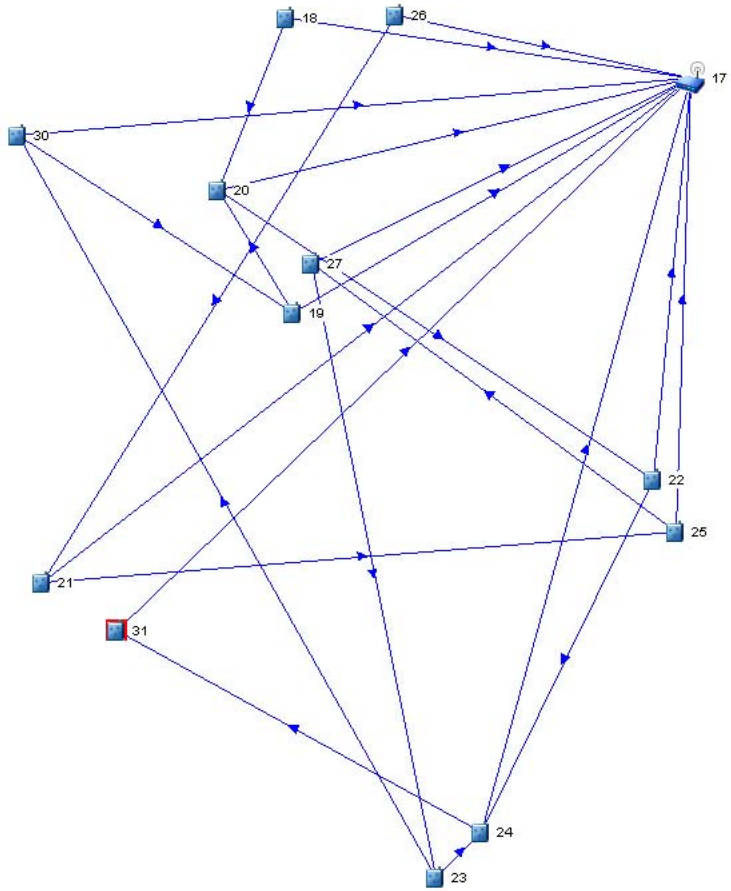
IOWA ENERGY CENTER

Installation

- 12 motes
- 1 manager
- Installed in < 2 hrs

… facilitated by mesh networking

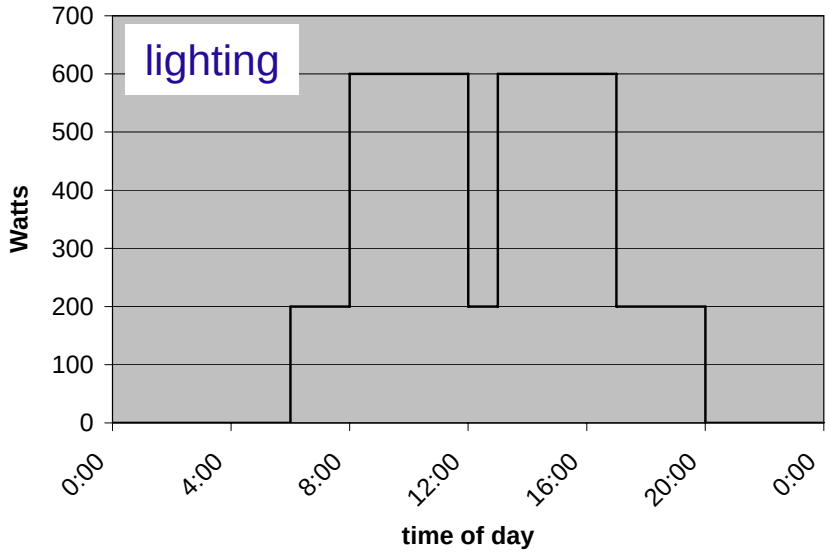


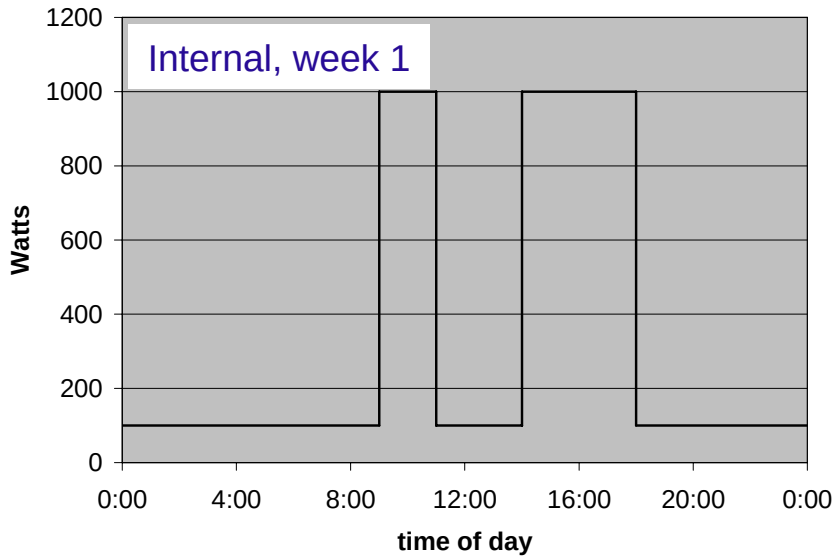


IOWA ENERGY CENTER

Test conditions

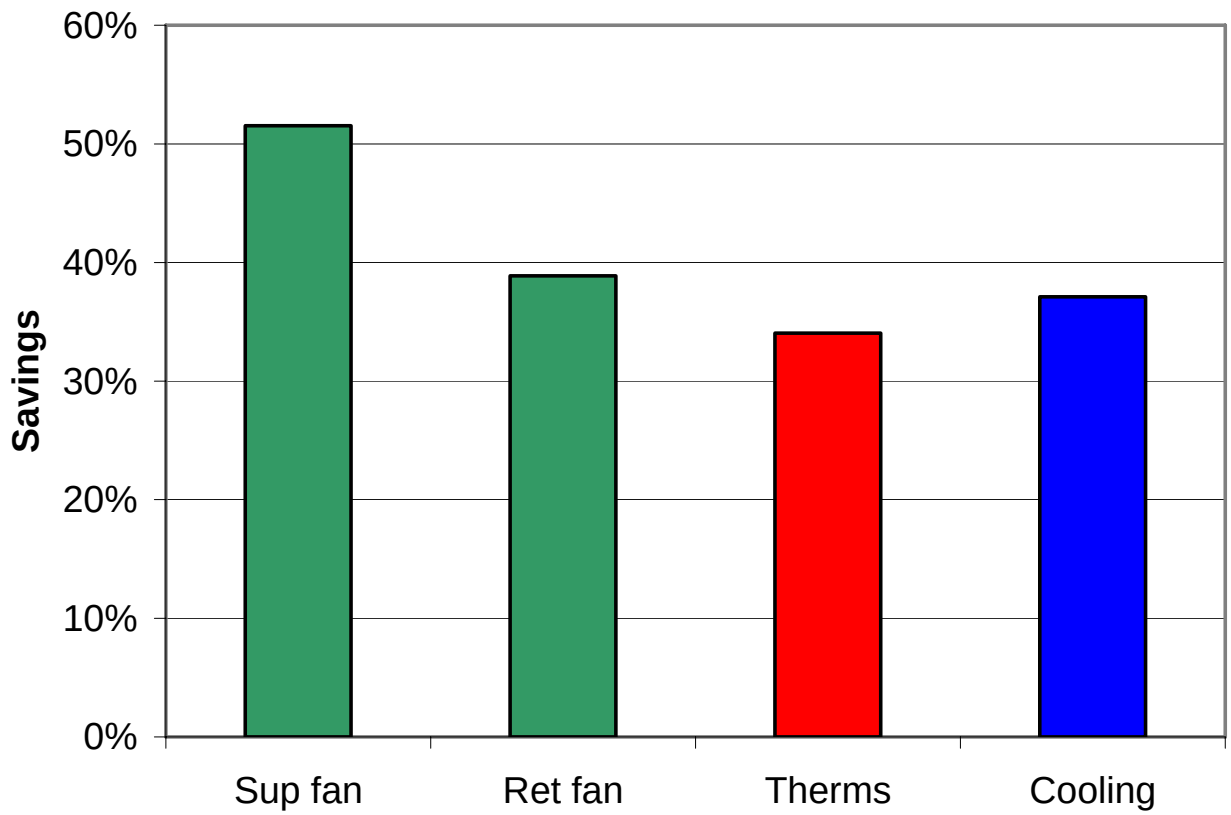
- Week 1
  - 2.2 W/sf lighting (max)
  - 3.7 W/sf internal (max)
  - Blinds horizontal
  - 2.4 CFM/sf perimeter
  - 1.1 CFM/sf interior
  - 40% min fan speed
  - 24/7 operation
- Week 2
  - 1.1 W/sf internal (max)
  - Proportional zone control to emulate pneumatics





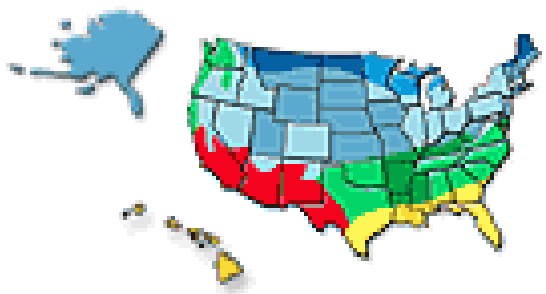
Measured energy savings

- 3.7 kWh/sf/yr (6am – 6pm)
- 0.34 therms/sf/yr (6am – 6pm)
- Higher savings than conventional retrofits



CAV to VAV savings opportunity

- 3.5 billion square feet of constant volume HVAC
- 13 billion kWh/yr and 1.2 billion therms/yr saved
- $2.5 billion/yr saved
- Large buildings
- College campus buildings, public buildings, office buildings constructed before 1985

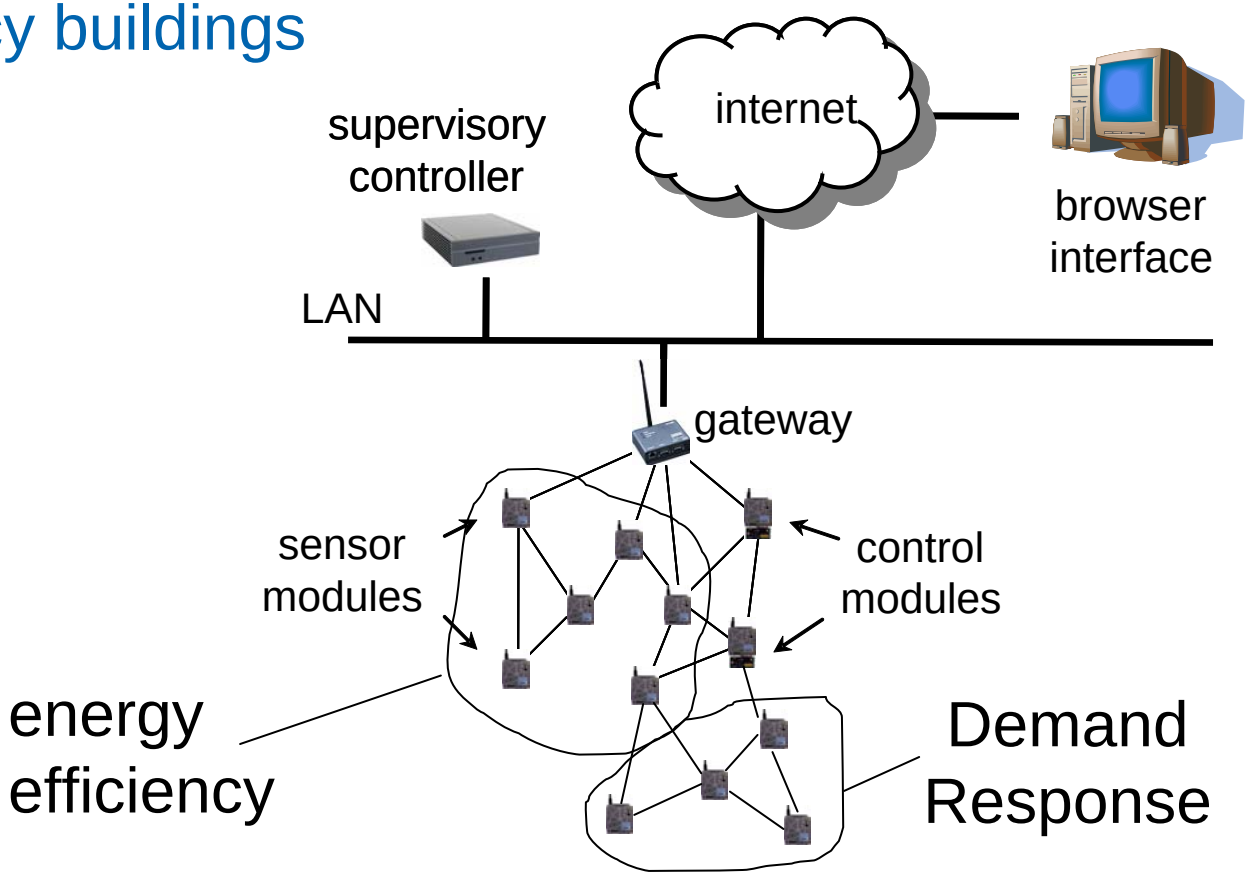


Energy management applications

- CAV to VAV retrofits
- **Demand response**
- Data center cooling control

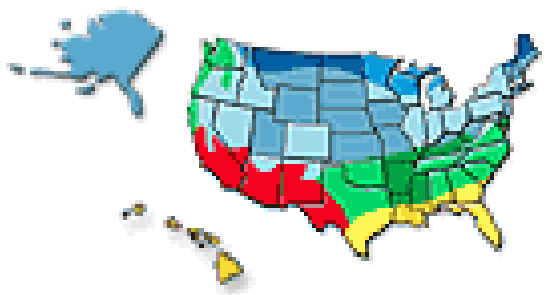
Wireless DR

- Add-on to an EE system
- Low incremental cost
- DR in legacy buildings



DR market today

- Market not well-defined yet
- Dynamic utility rates in many states
- Aggregators contract with ISOs/utilities and end users



Energy management applications

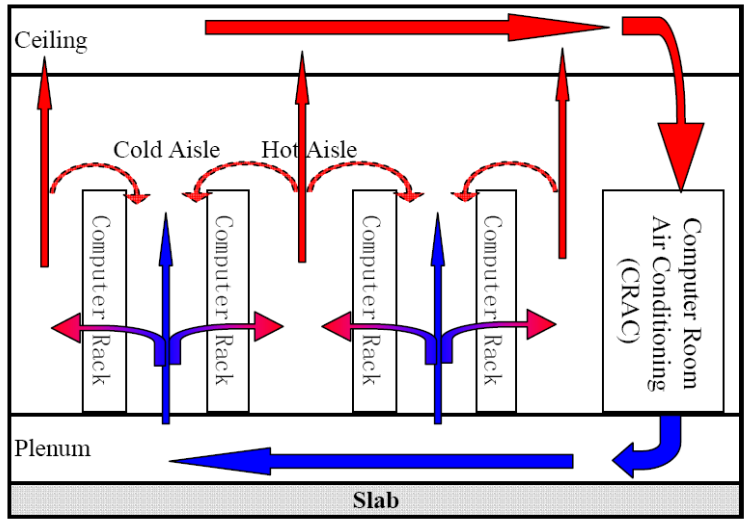
- Constant volume to VAV
- Demand response
- **Data center cooling control**

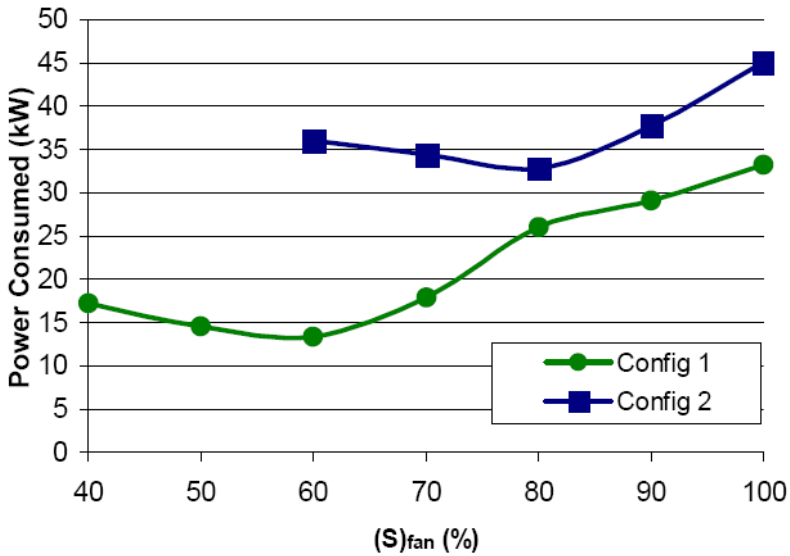
Problems with data center cooling

- Server mfrs specify server inlet temps
- CRAC units measure return temp
- Setpoint is very low because there is no direct feedback
- One CRAC unit failure may not be detected by other CRAC units

Solution

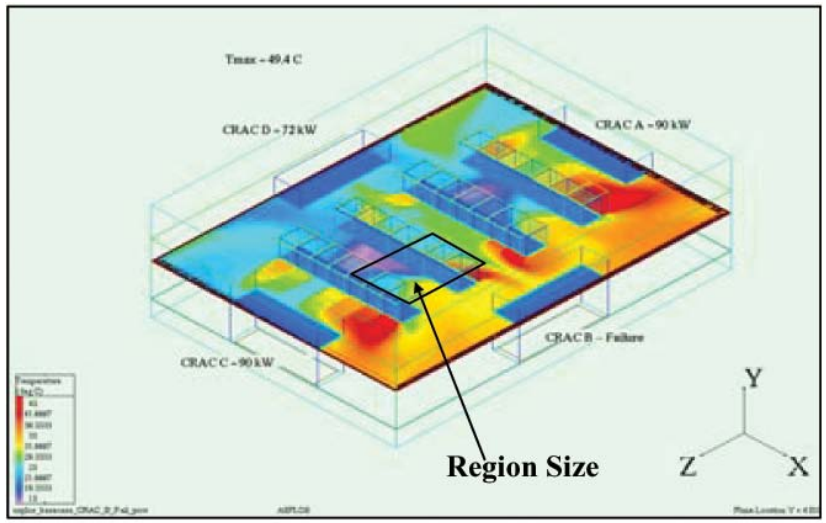
- Measure server inlet temps with wireless sensors
- Control highest temp
- “Measure” power consumption
- Optimize fan speed

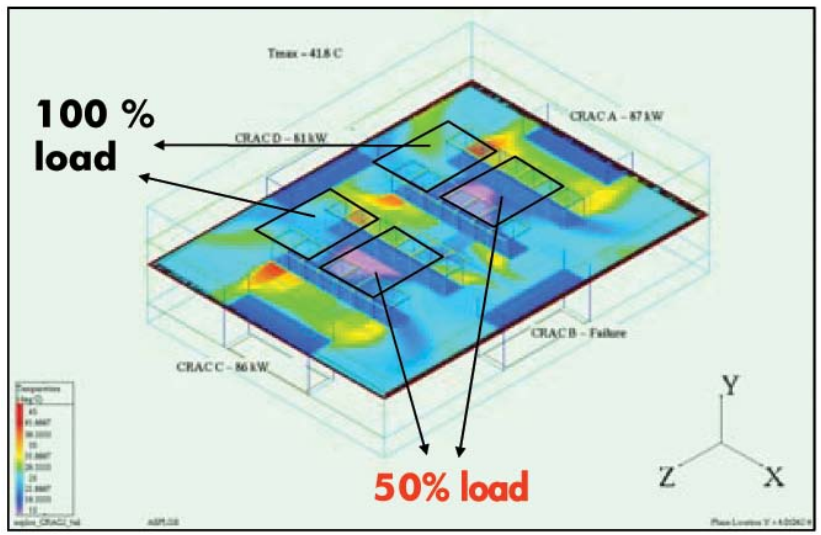




Benefits

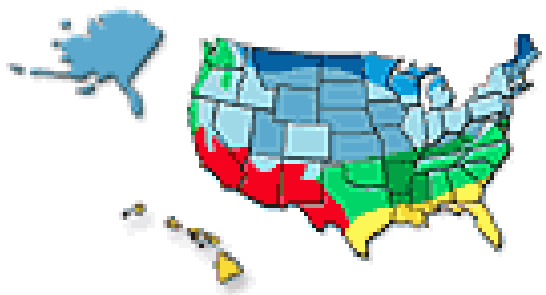
- Better energy performance
- Better thermal management





Why-R-Less?

- Less time required for installation
- Less business interruption
- Less energy consumption



Questions?

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