Computer Science for Energy Conservation

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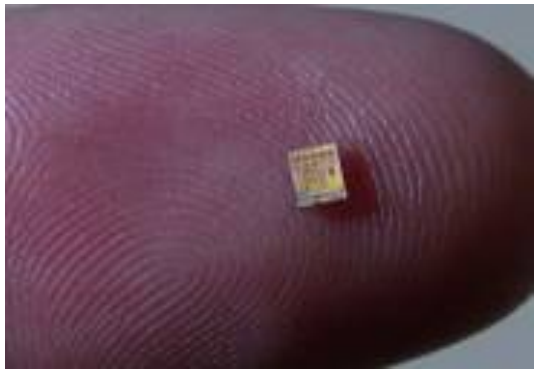
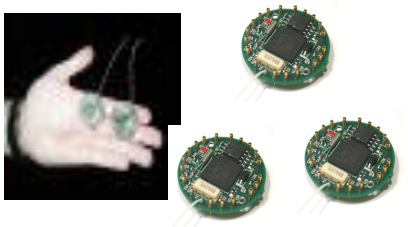
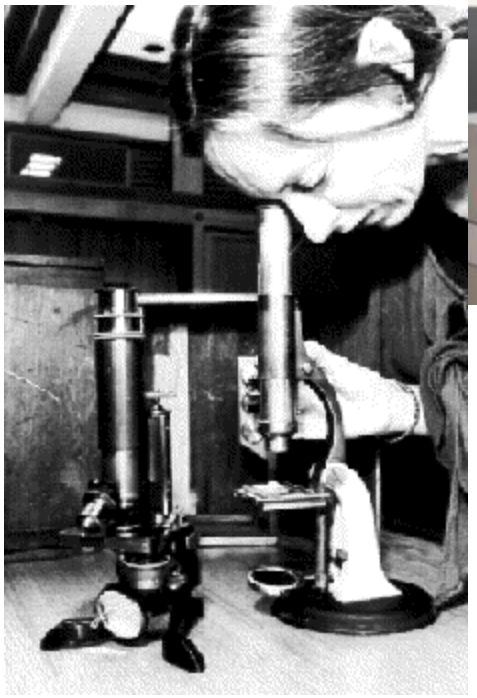
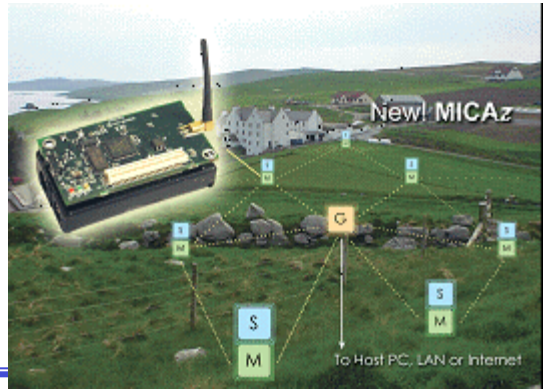
The New Computer Science



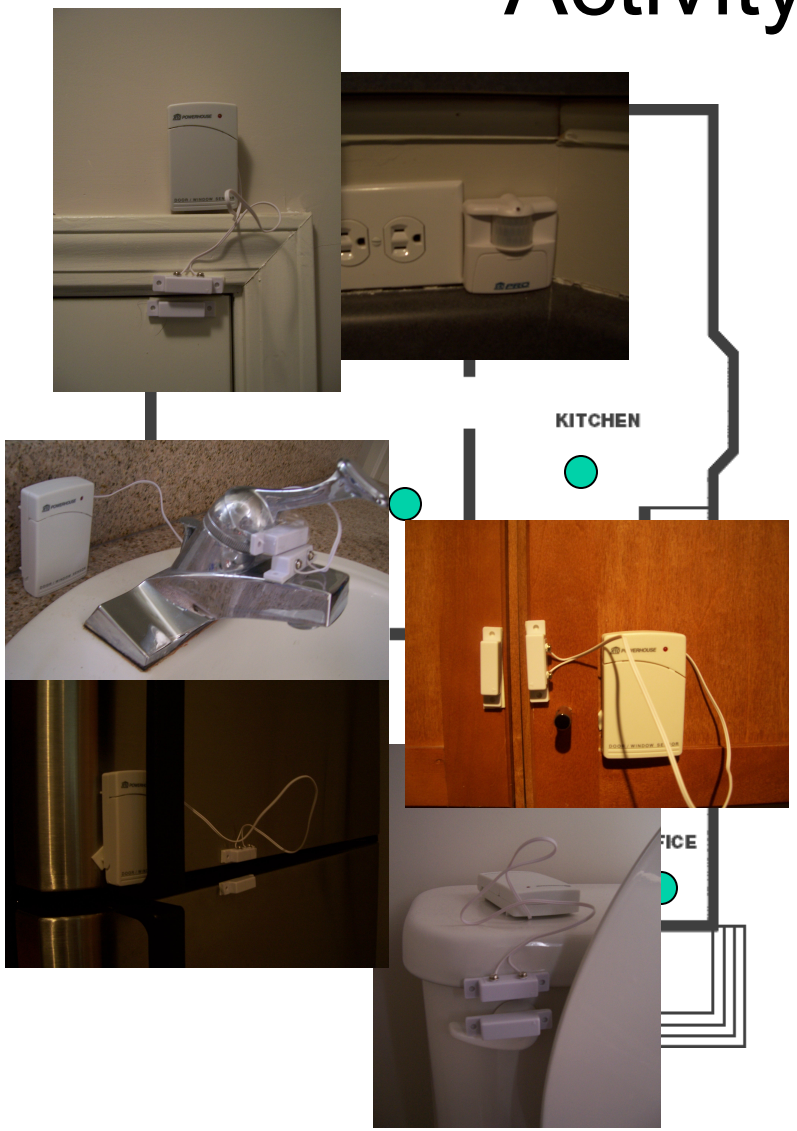


The Age of Embedd puting



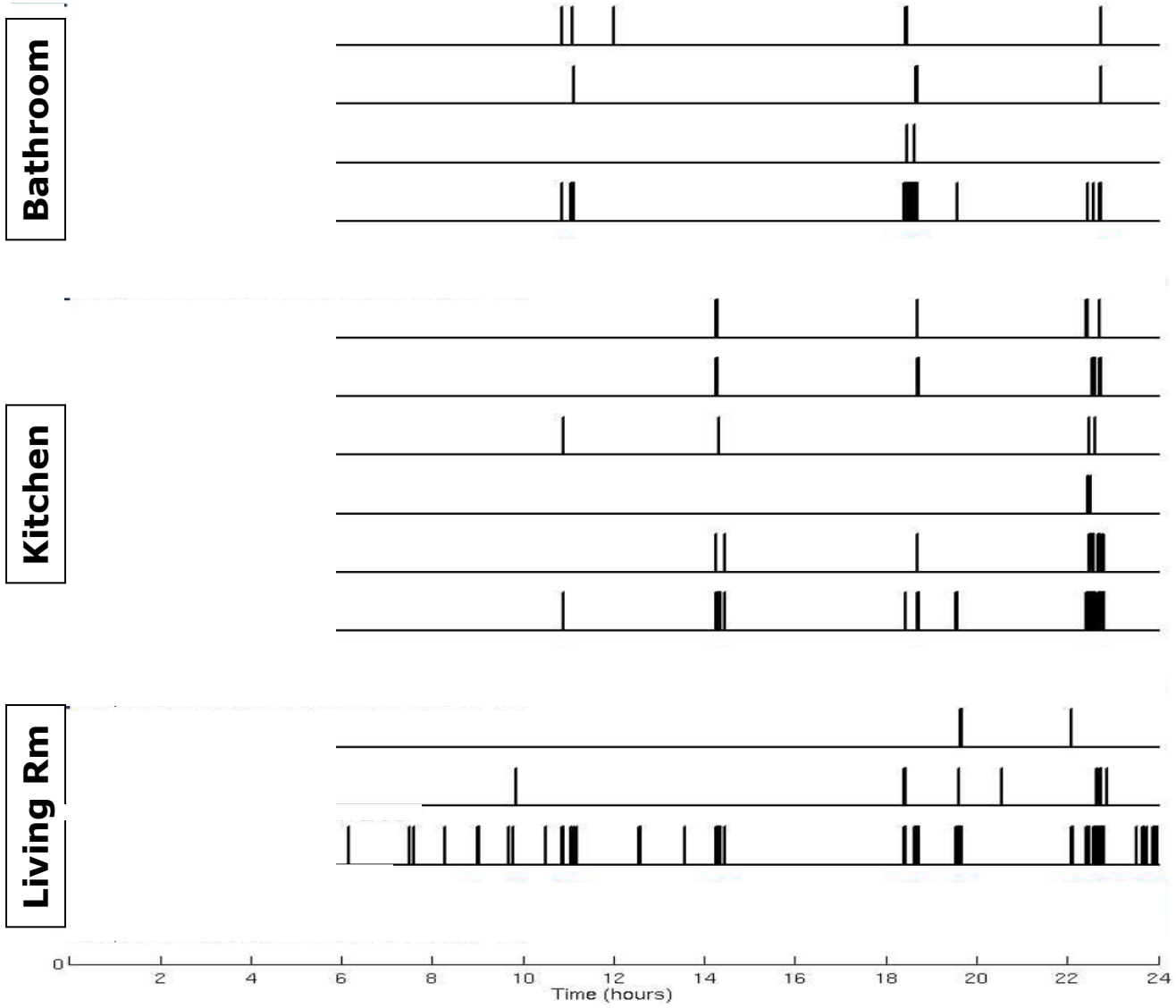


Activity Inference

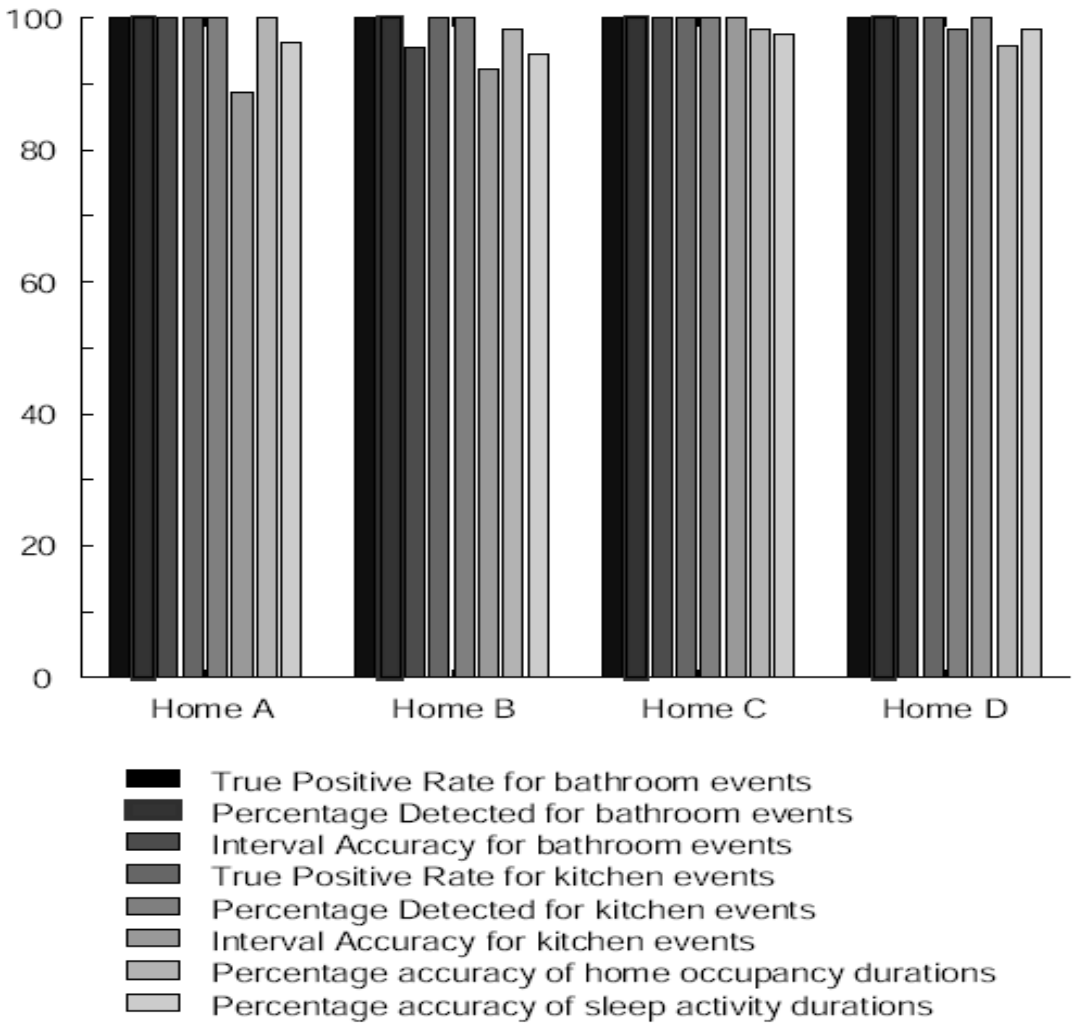


- Home or away
- Awake or asleep
- Bathroom usage
- Kitchen usage
- Showering, toileting, washing
- Cooking hot food or preparing cold food

Activity Inference

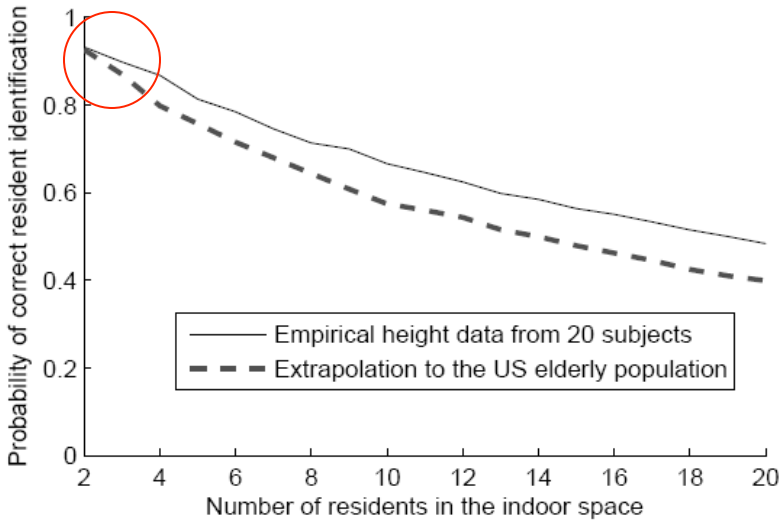


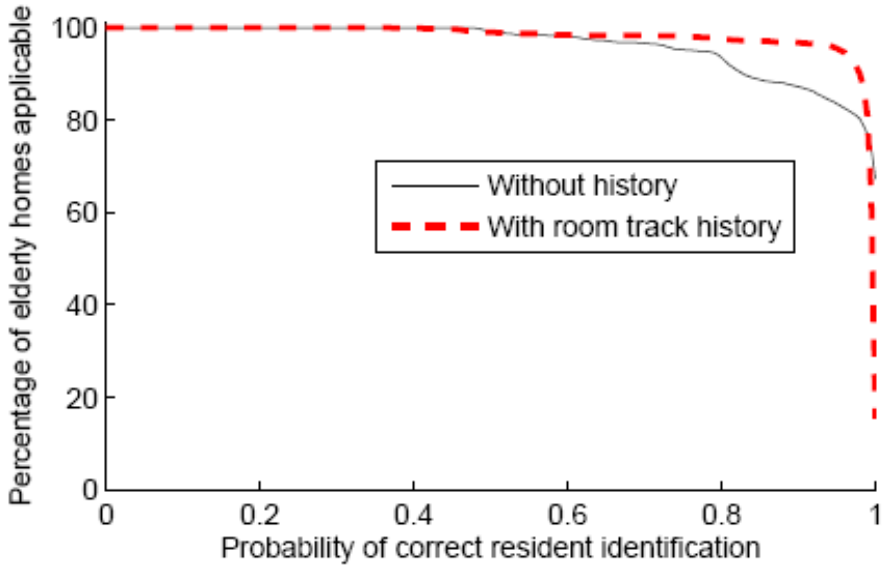
FATS success across 4 homes



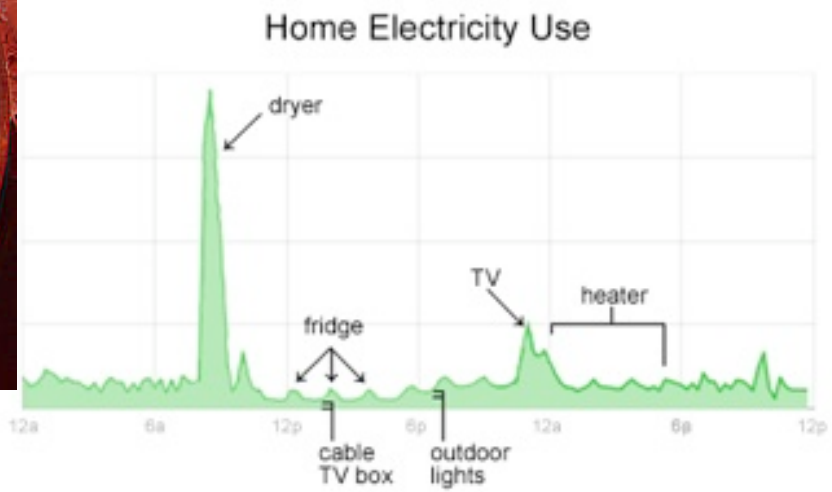
Focus - HomeSounds

Height sensor under doorways





Power Metering



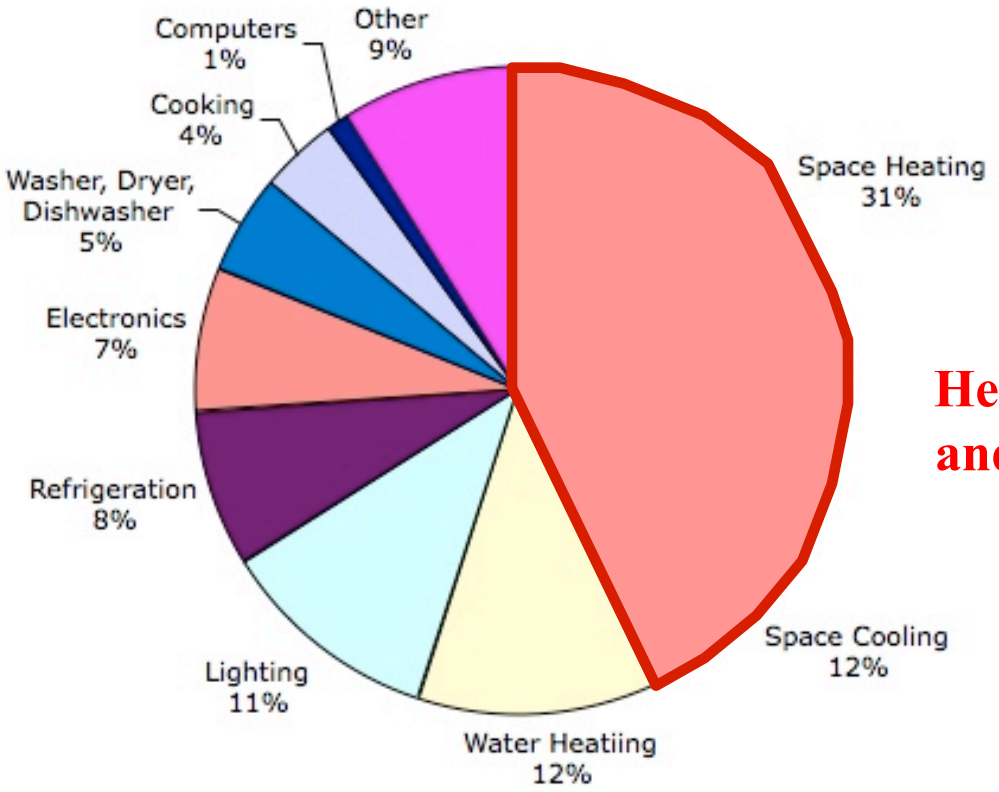
Note: labels in this graph are demonstrative, and are not part of PowerMeter's current design.

Analyze:
Get better information about how you use energy and what you can do to be more efficient.

Save:
Reduce your energy bills and carbon footprint by making smart decisions about your energy use.

Share:
Strike up a little friendly competition to see how your energy consumption compares to your friends and neighbors.

Home Energy Consumption



Heating, ventilation, and cooling (HVAC)

Residential Energy Usage, 2006

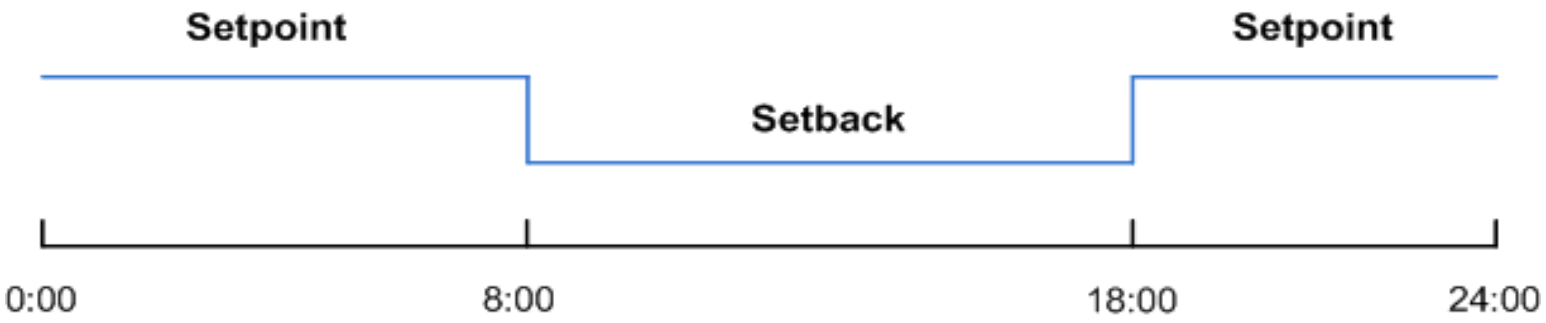
National Academy of Sciences

Problem Definition

- But reducing HVAC energy --> **$$**
  - Insulation, new windows, solar panels, geothermal, HVAC upgrades, etc.
  - All require $1000's and take many years for ROI
- Federal stimulus: **$5 billion** for weatherization of low-income homes
  - Small % of target savings
- We need low-cost energy solutions

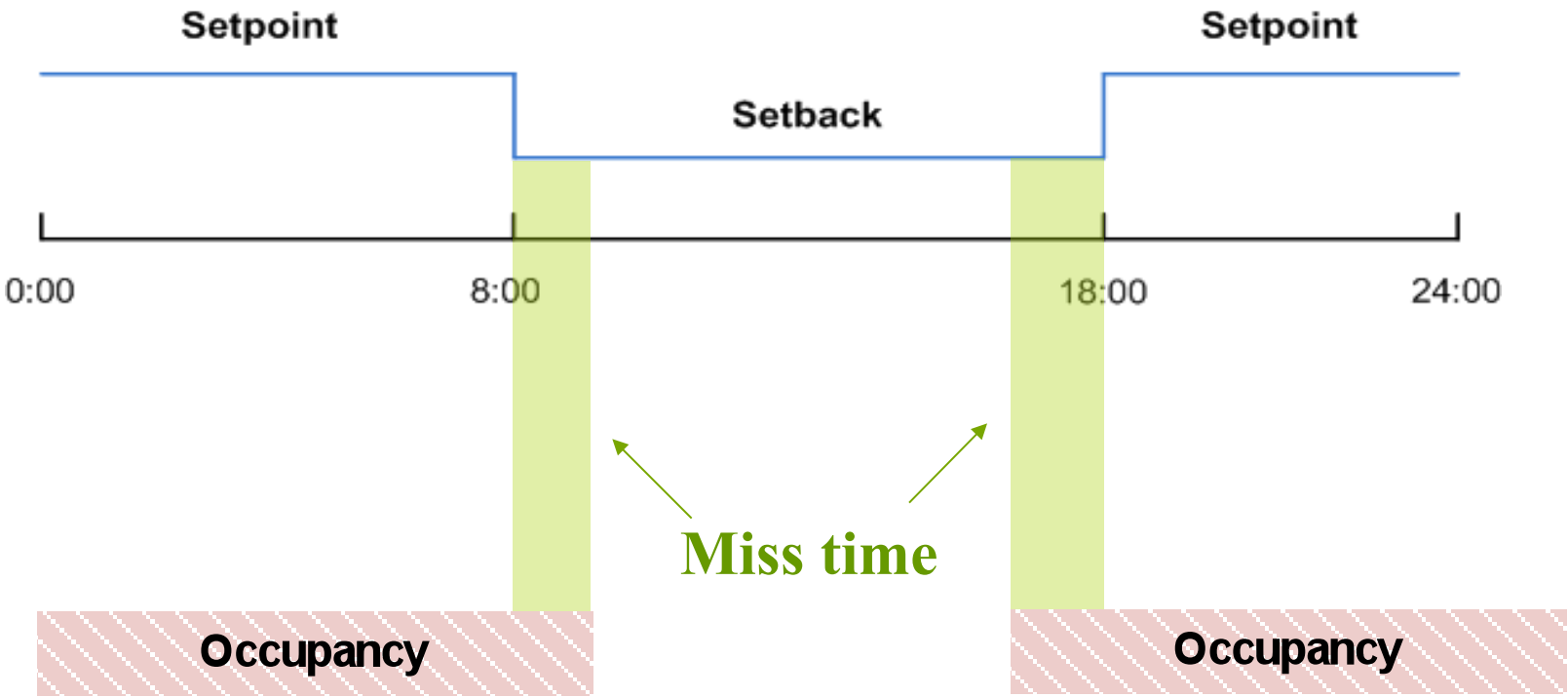
State of Art

- Programmable thermostat

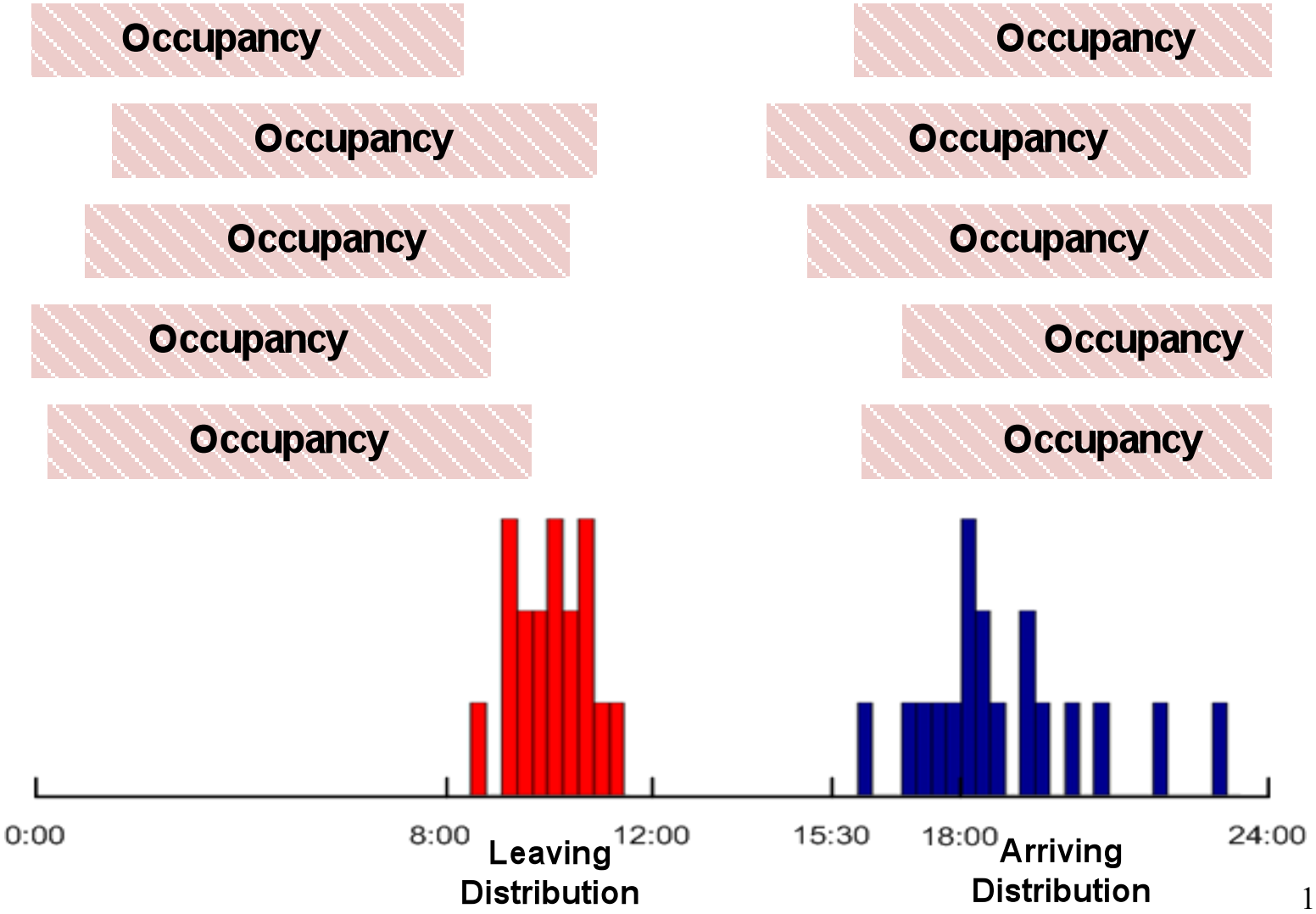


  - Widely-accepted
  - Cost-effective
  - But still largely untapped potential!
    - a majority of users cannot set programmable thermostats correctly (5-15% waste)

Miss Time

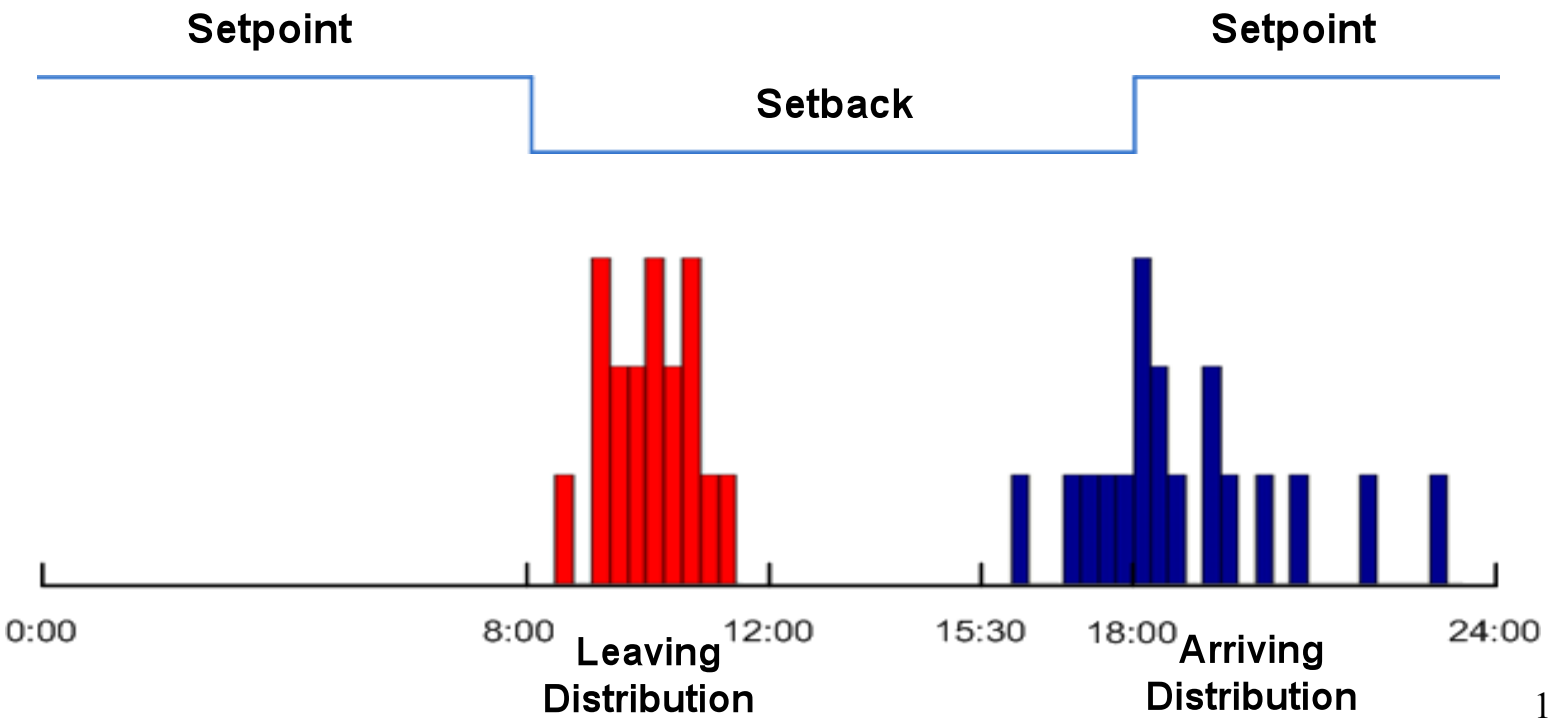

Setpoint
Setpoint
Setback
0:00
8:00
18:00
24:00
Miss time
Occupancy
Occupancy

Occupancy Patterns



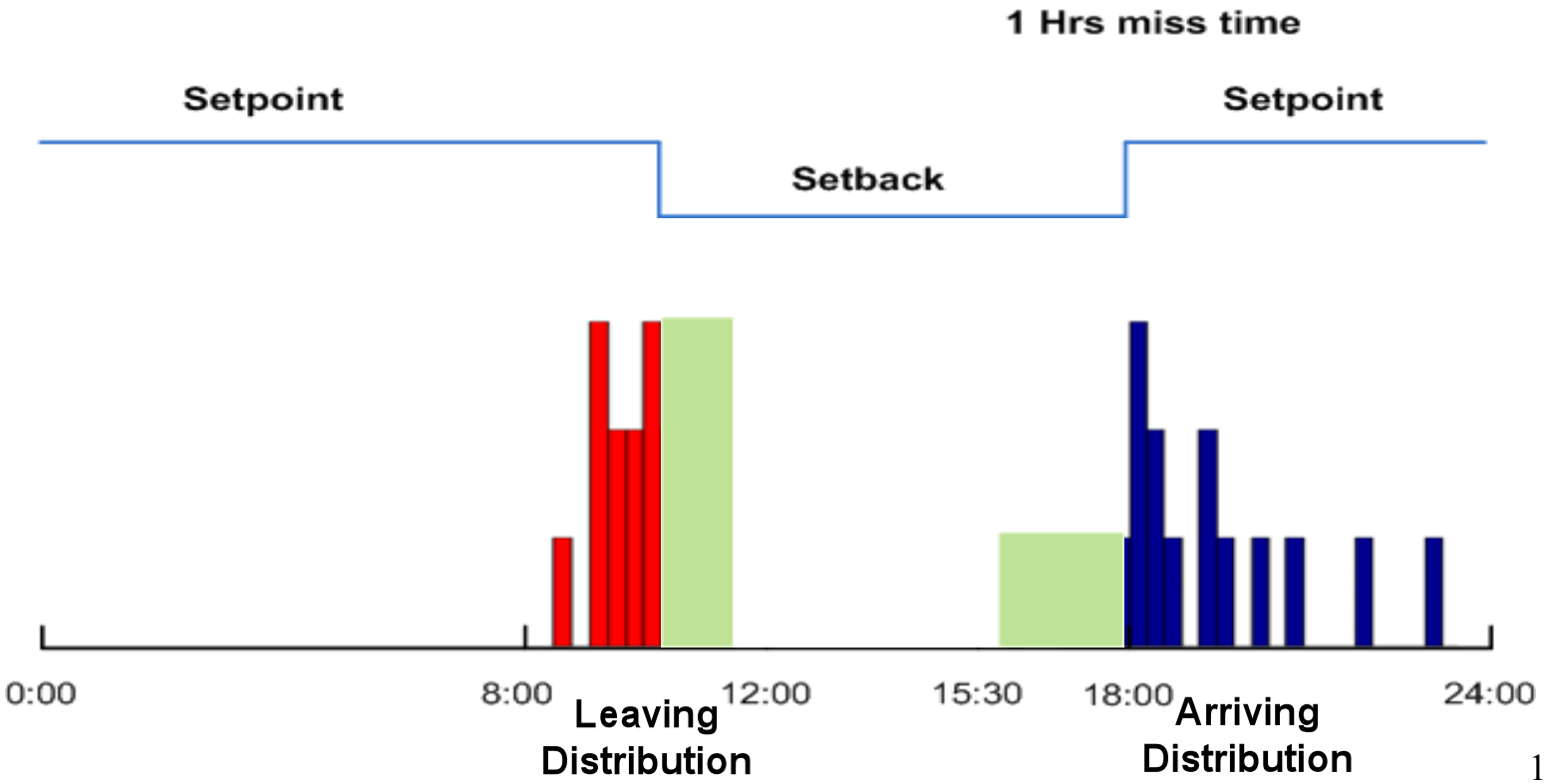
Smart Thermostat

- Goal: occupant-oriented HVAC control to reduce energy consumption without reducing comfort level



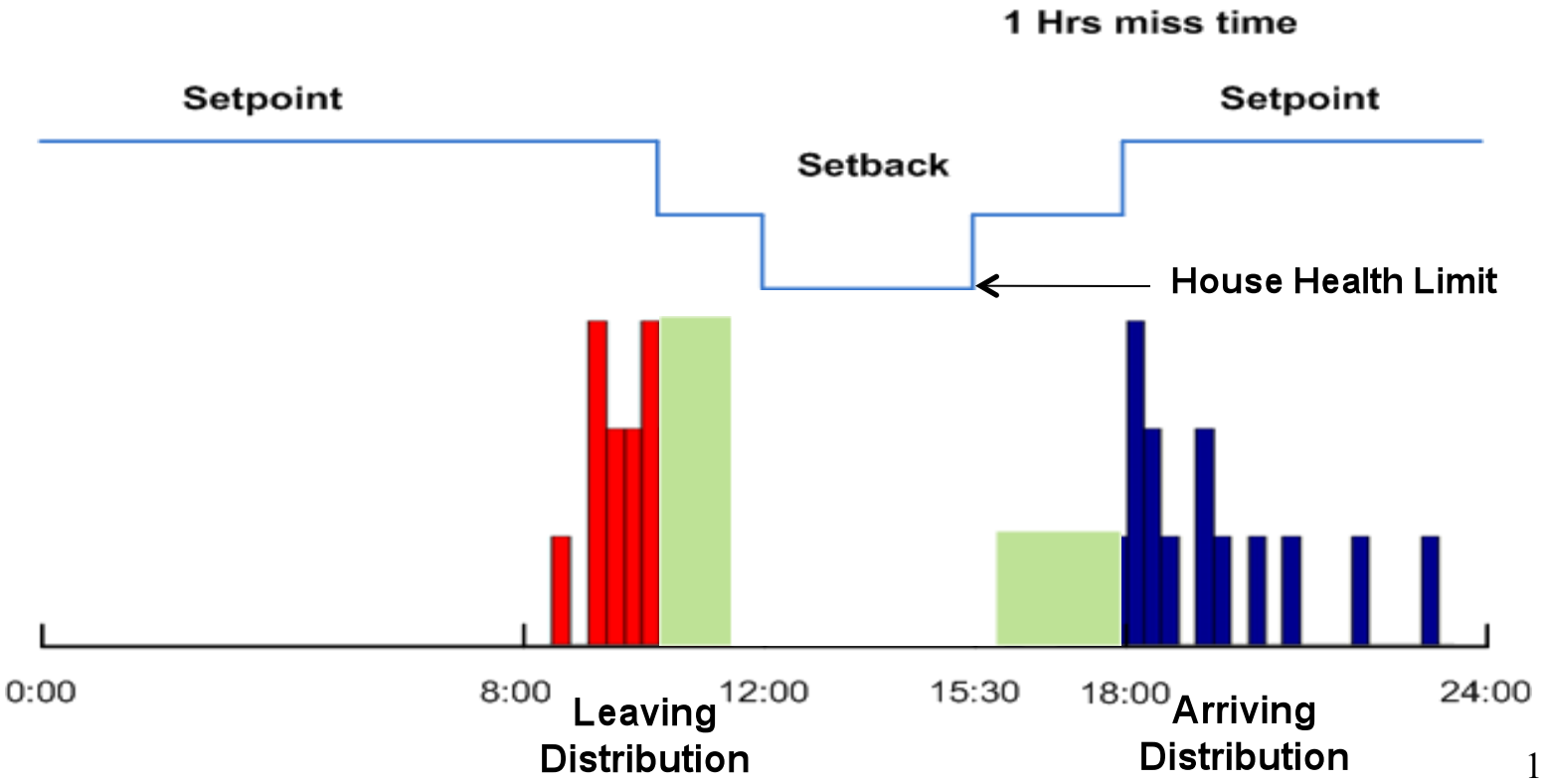
System Design

- Comfort risk
  - User specifies the allowable time duration for active occupancy while not conditioned to the setpoint temperature



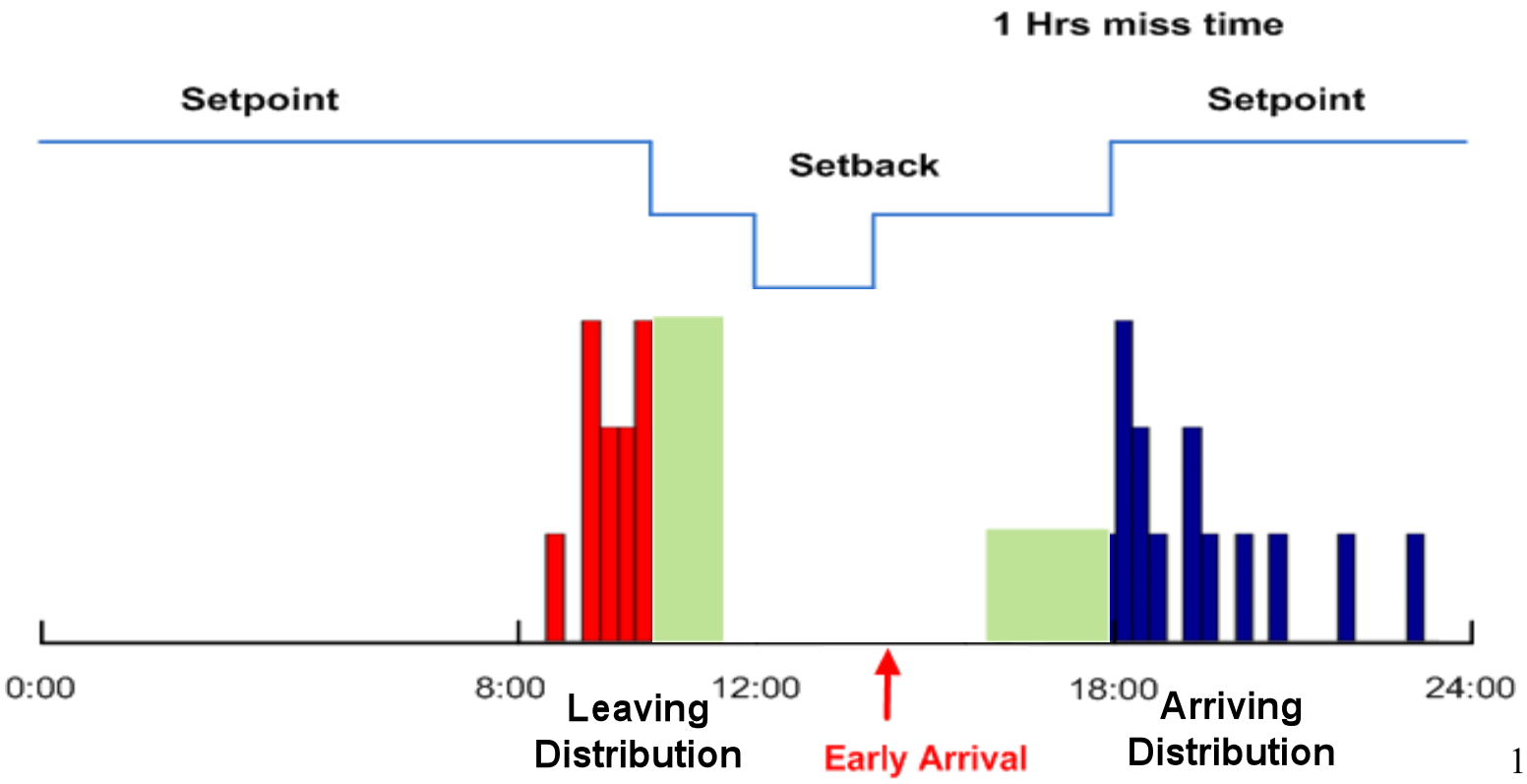
System Design

- Offline algorithm
  - Create the optimal setback schedule that minimizes energy consumption based on long-term occupancy pattern and the given comfort risk



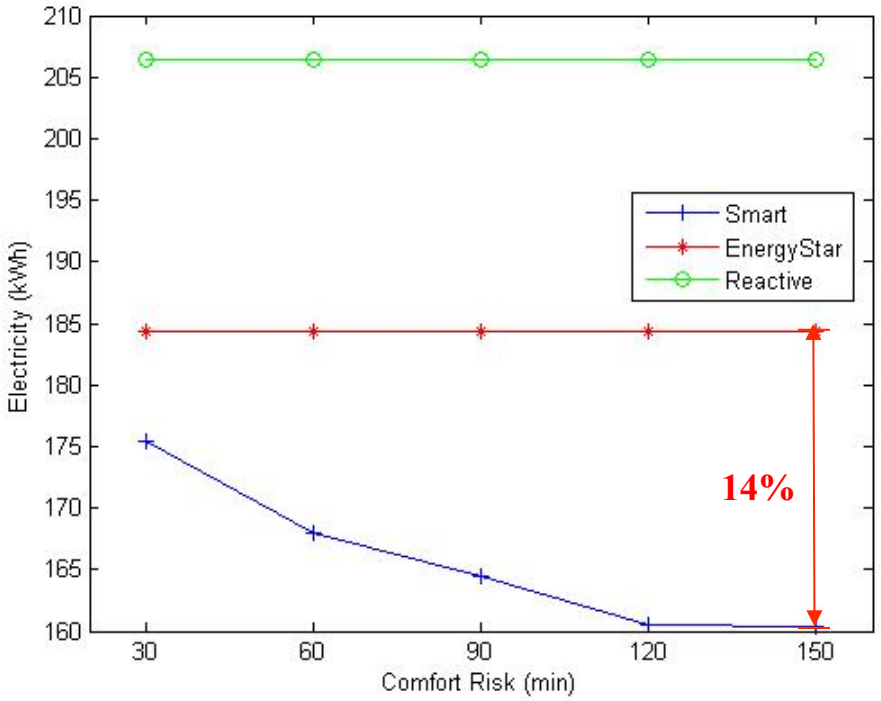
System Design

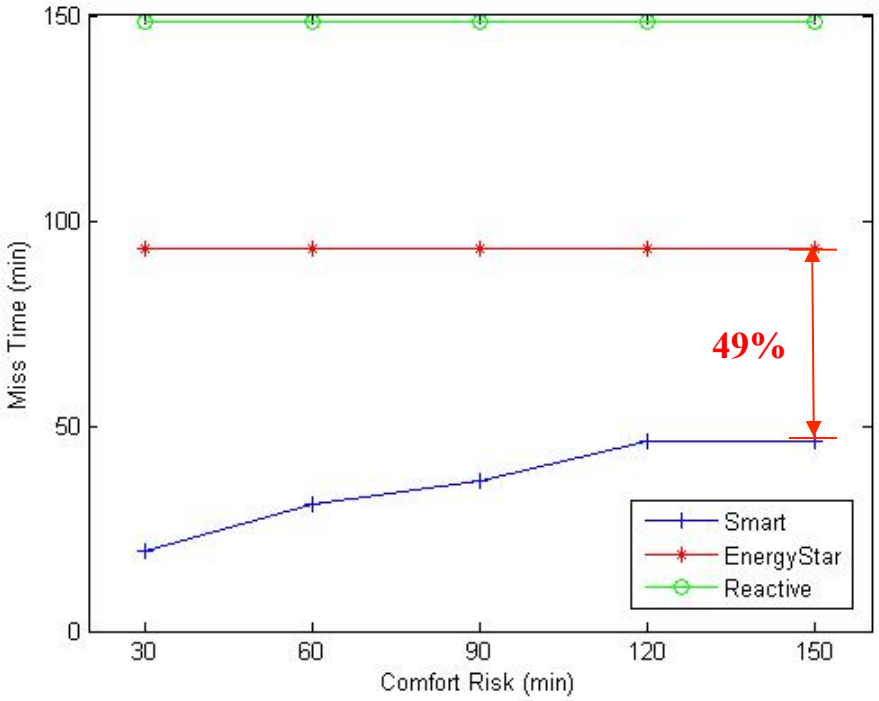
- Online algorithm
  - Reactive in real time to unexpected occupancy events



Comfort Risk Knob

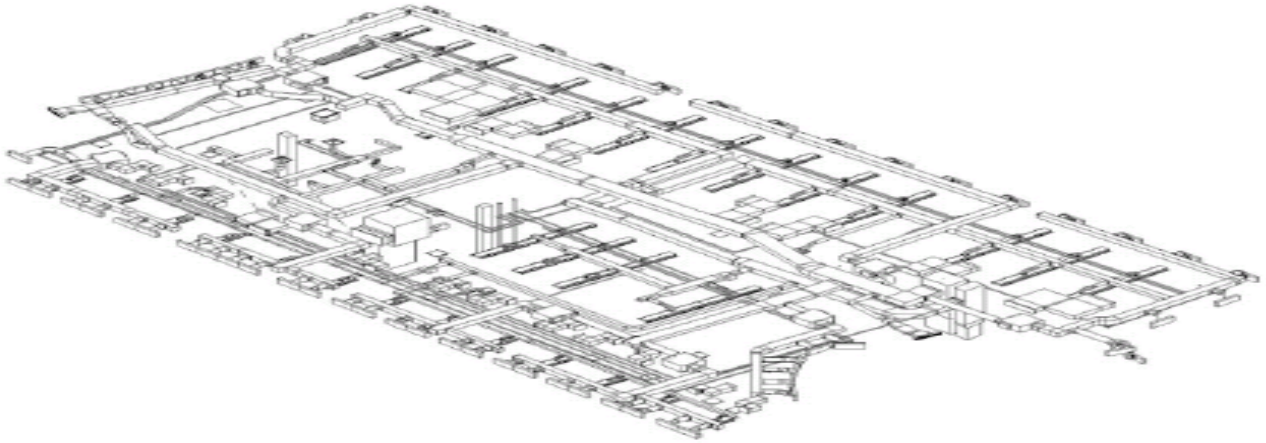
- Comfort vs. Energy





Next Steps

- Micro-zoning
  - Learn which rooms and which people
  - Control rooms individually
- Extend to office buildings
  - “Living laboratory” being built
  - Each room is independently controlled



Thank you!

- If interested in research contact:

  whitehouse at virginia

Questions?