Architecture and Algorithms for the LSE to Manage Thermal Inertial Loads

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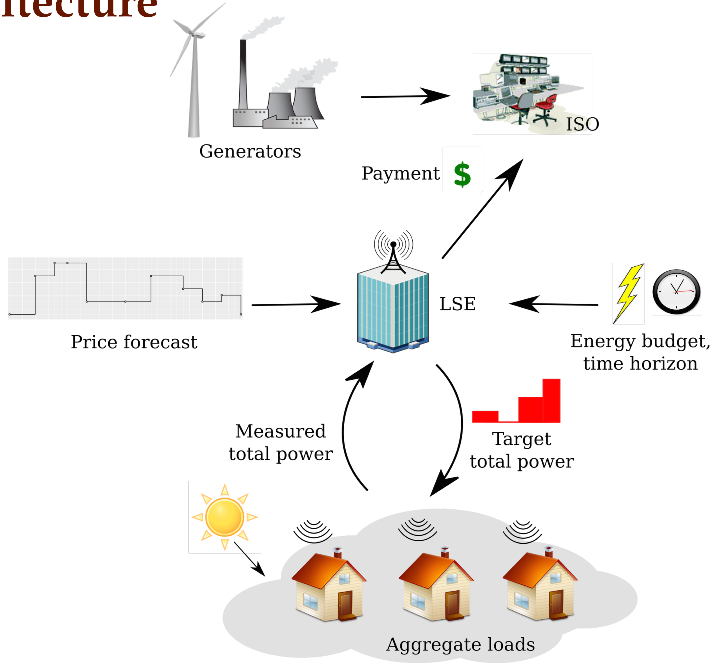
Joint work with X. Geng, F.A.C.C. Fontes, P.R. Kumar, and L. Xie

Controlling Air Conditioners

Direct Control for Demand Response

Architecture



Research Scope

Objective: A theory of operation for the LSE

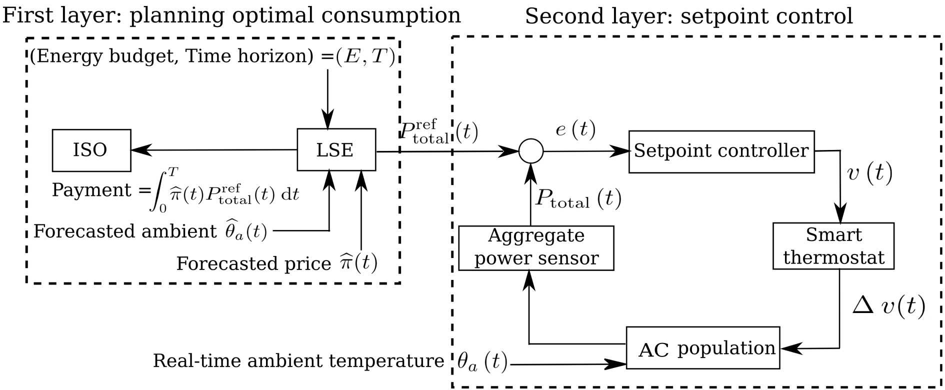
Challenges:

1. How to design the **target consumption as a function of price**?

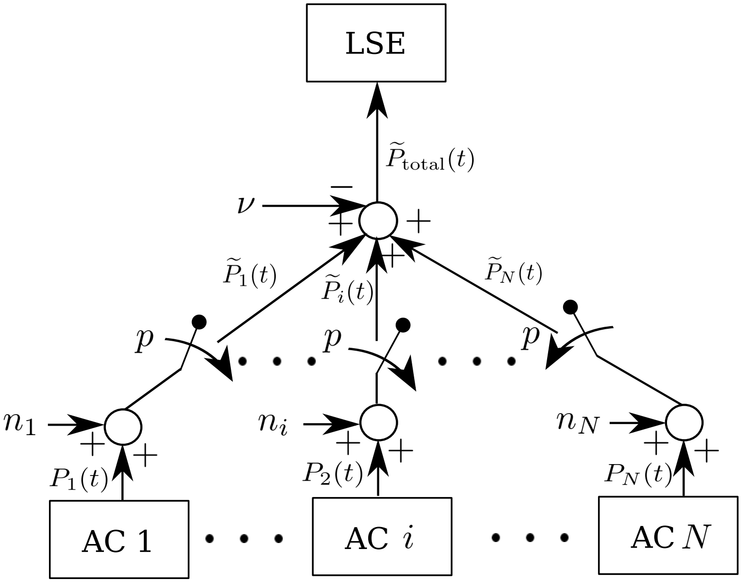
2. How to control so as to preserve **privacy** of the loads' states?

3. How to respect loads' **contractual obligations** (e.g. comfort range width Δ)?

Two Layer Block Diagram



Privacy Preserving Sensing



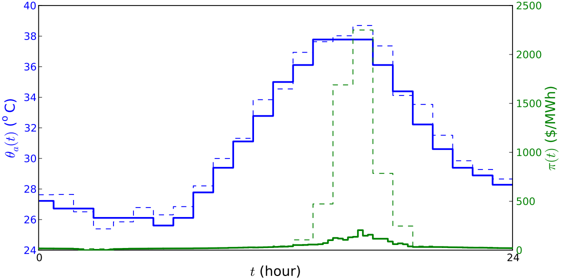
Simulation: 500 homes + ERCOT DA price

- - forecasted ambient

— actual ambient

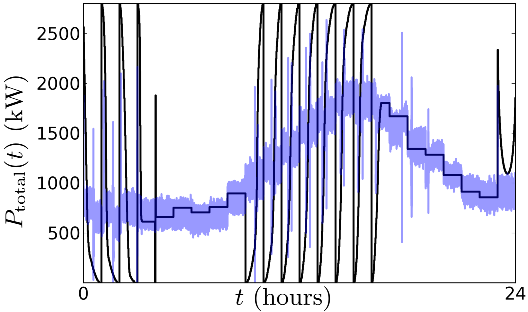
- - forecasted price

— actual price

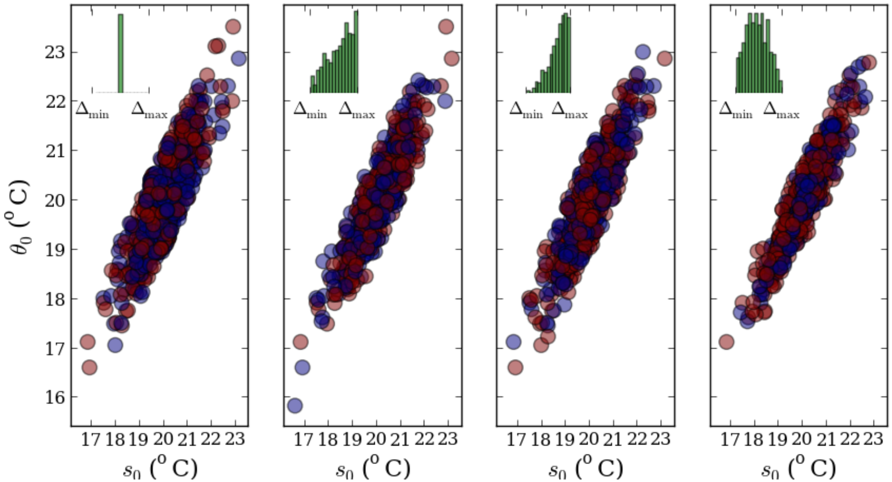


— target consumption

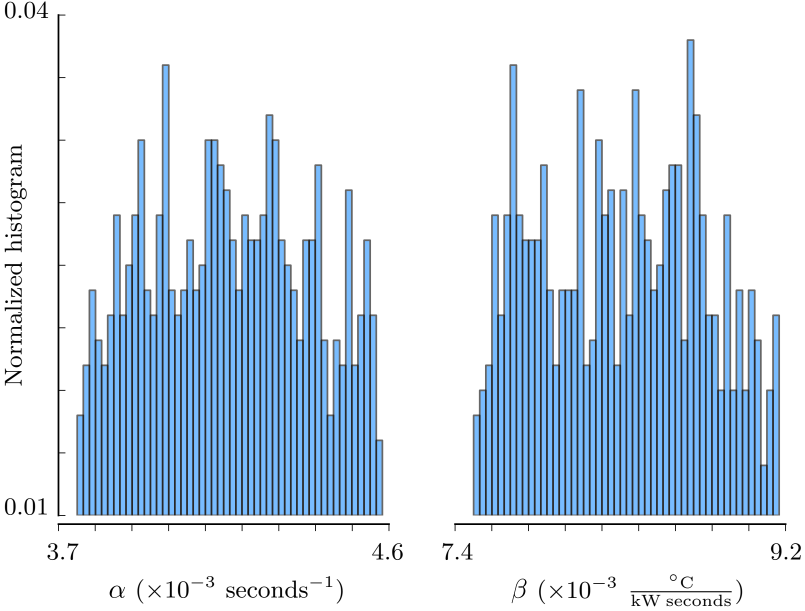
— actual consumption



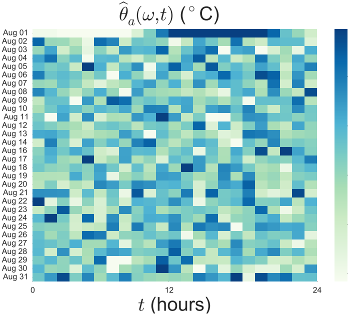
Initial Conditions

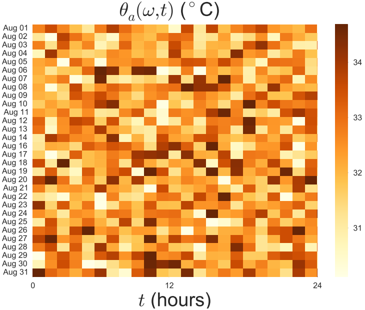


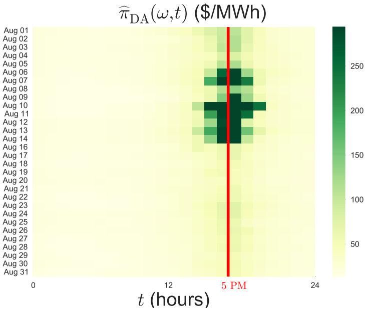
Parameters α and β

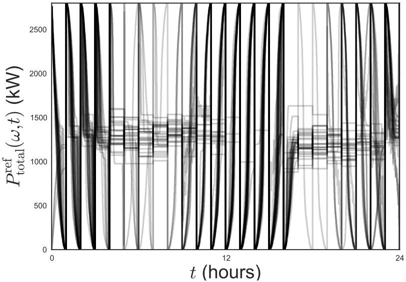


Houston Data for August 2015

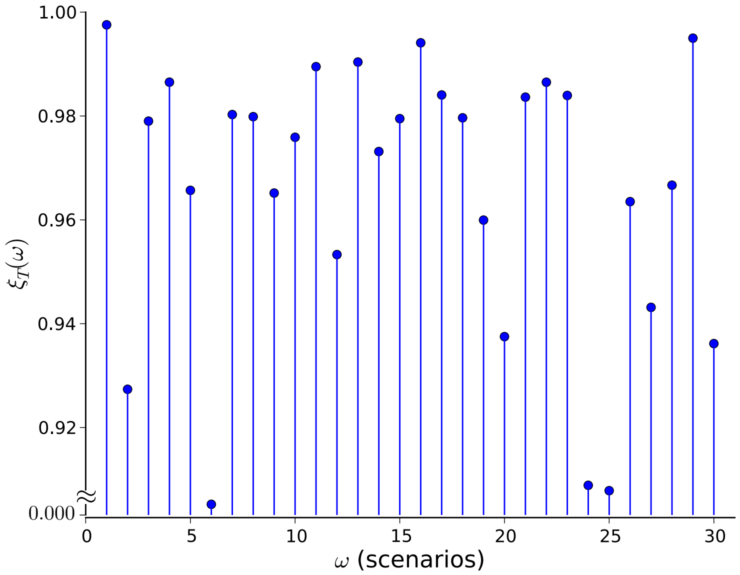




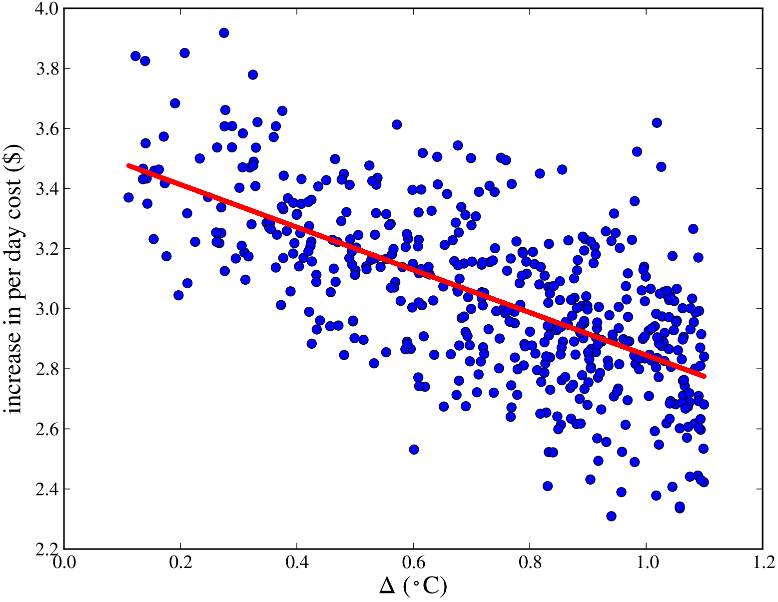




Limits of Control Performance



How Can the LSE Price A Contract



Summary

1. Privacy preserving aggregate sensing
2. Individual comfort guarantees
3. Contract cost $\propto$ QoS
4. Mathematically optimal, no ad-hoc fix

Wishlist

1. Hardware implementation of thermostatic control
2. Pilot project to implement the architecture

Thank You

Backup Slides

Details in

1. **A. Halder**, X. Geng, G. Sharma, L. Xie, and P.R. Kumar, "A Control System Framework for Privacy Preserving Demand Response of Thermal Inertial Loads", *SmartGridComm*, 2015.
2. **A. Halder**, X. Geng, P.R. Kumar, and L. Xie, "Architecture and Algorithms for Privacy Preserving Thermal Inertial Load Management by A Load Serving Entity", *accepted, IEEE Trans. Power Systems*, 2016.
3. **A. Halder**, X. Geng, F.A.C.C. Fontes, P.R. Kumar, and L. Xie, "Optimal Power Consumption for Demand Response of Thermostatically Controlled Loads", *under review, ACC*, 2017.
4. **A. Halder**, X. Geng, F.A.C.C. Fontes, P.R. Kumar, and L. Xie, "Deterministic and Stochastic Optimal Control of Thermal Inertial Loads", *working manuscript, available upon request*.