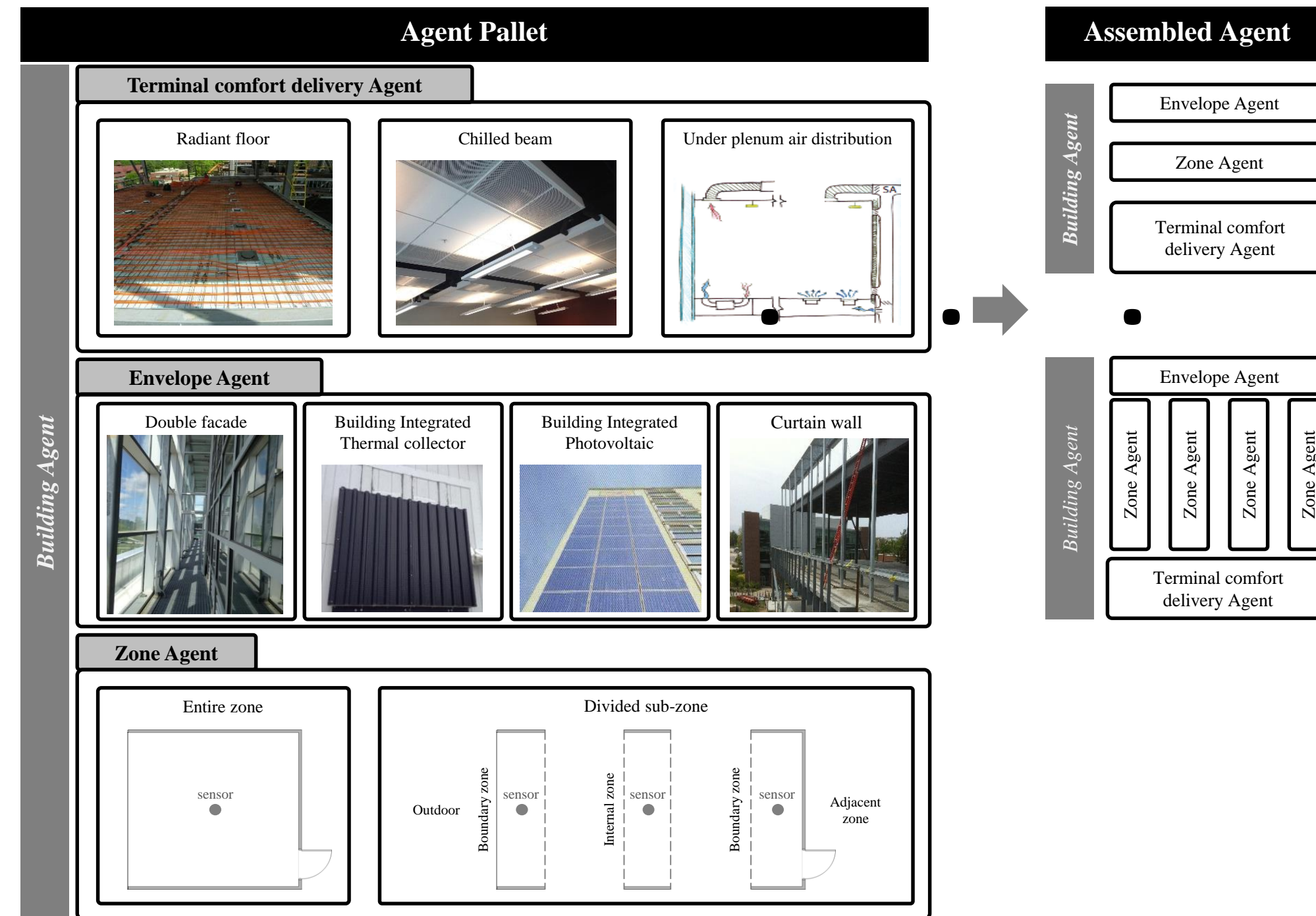


Vision

Modular Plug-and-Play Buildings Control

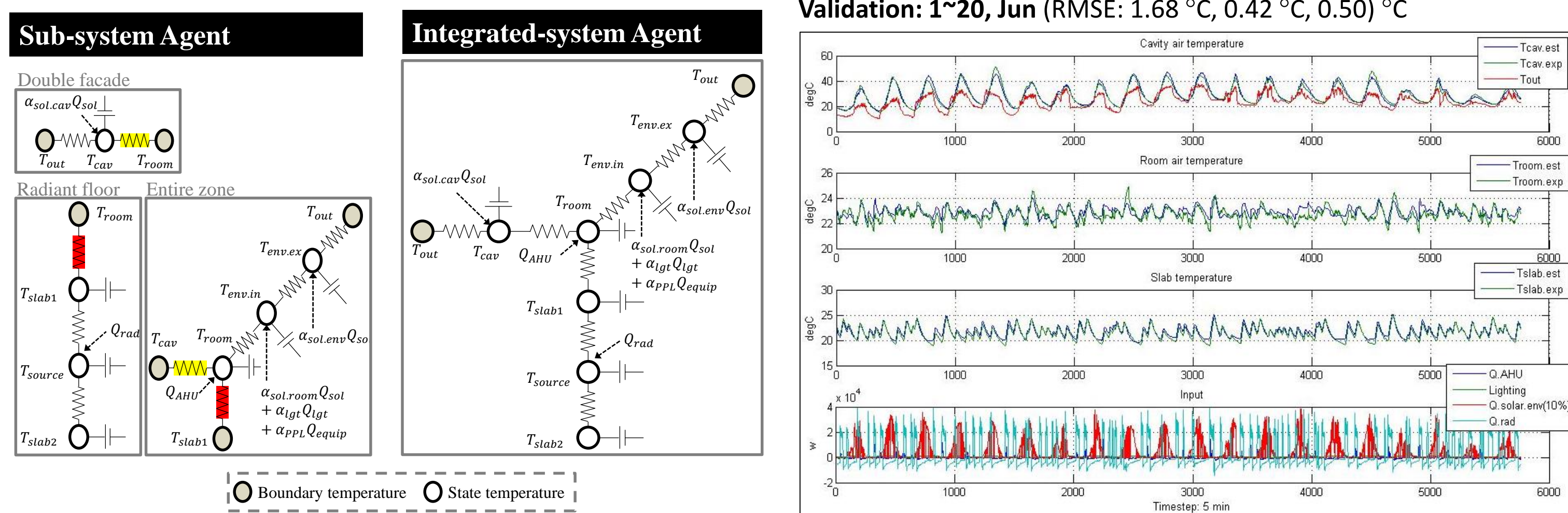
- Pre-engineered intelligent modules
- Plug-and-play building control
- Advantages:
 - Flexibility
 - Configurability
 - Scalability



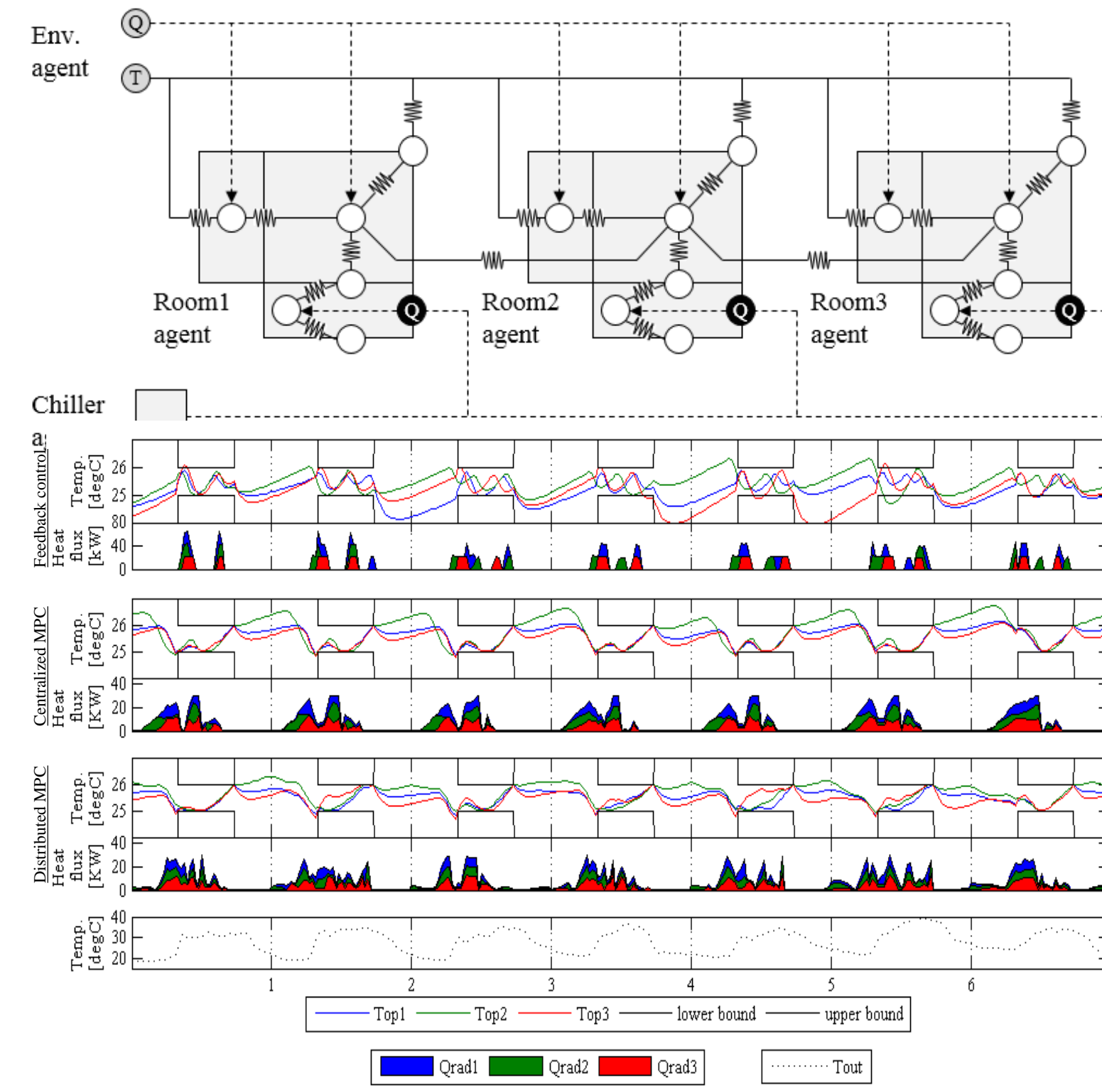
Agent-based Model Identification & Control

Case Study: Radiant Floor Systems

- Agent-based method for distributed system identification
 - Identify agents and their individual models
 - Negotiate and reach consensus on shared parameters
 - Assemble agent models into agent network model



- Agent-based control using distributed MPC
 - Using Purdue Living Lab 1 (LL1) radiant floor system as a testbed
 - Evaluate energy saving potential vs. feedback control and centralized MPC



Saving vs. Baseline Feedback Control

	Centralized MPC	Distributed MPC
electricity	10.8%	9.8%
Utility bill	18.7%	13.8%
Demand charge	54.3%	53.5%

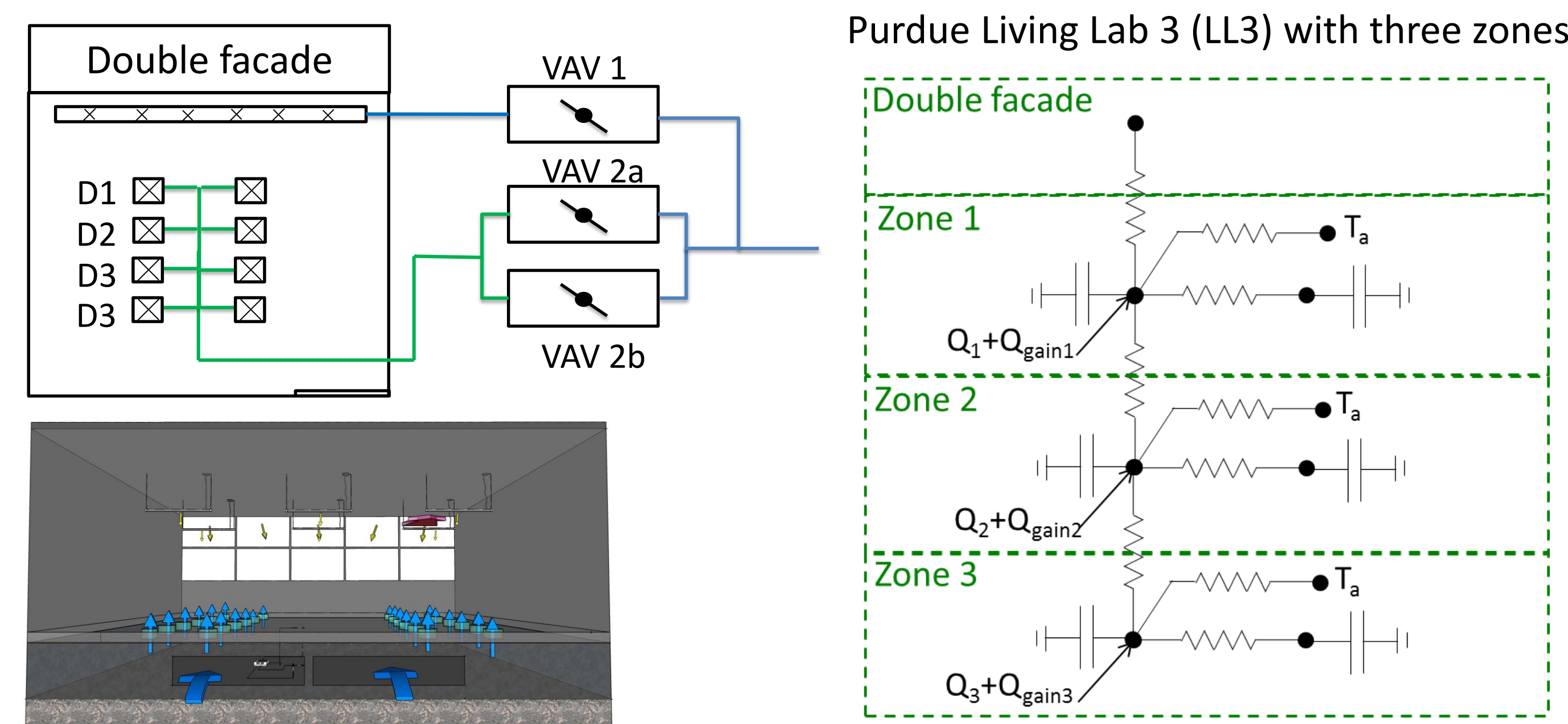
Conclusion:

- Significant energy saving vs. feedback control
- Reap most saving potential of CMPC
- Real-time implementation possible
- Extension to strongly coupled systems

Agent-based Coordinated Control

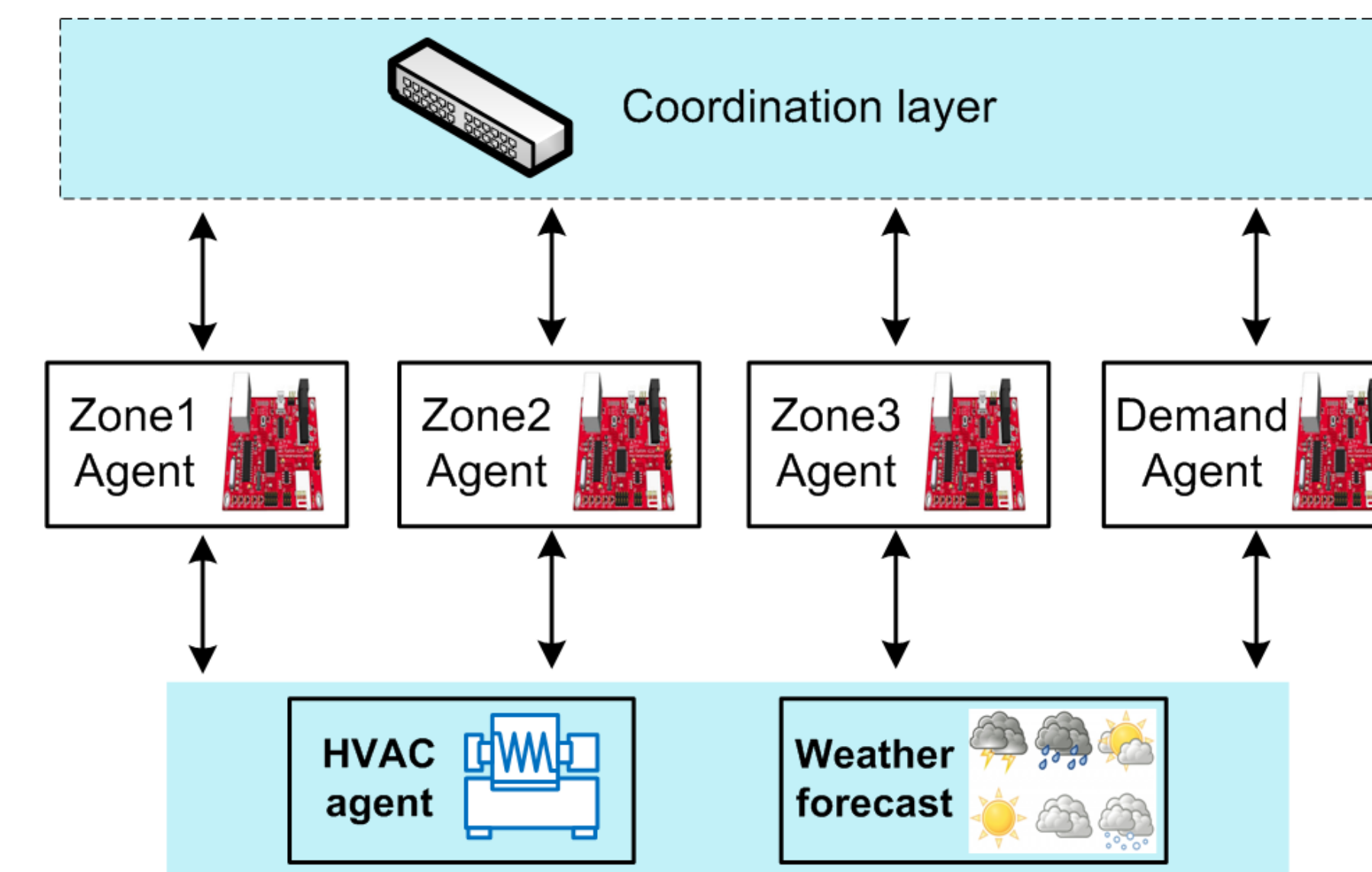
Case Study: Open-Space Multi-Zone Buildings

- A multi-zone office place with individual customizable comfort controls
- Objective:** save energy via spatially and temporally coordinated controls
- Approach:** distributed MPC with inter-zonal coordination

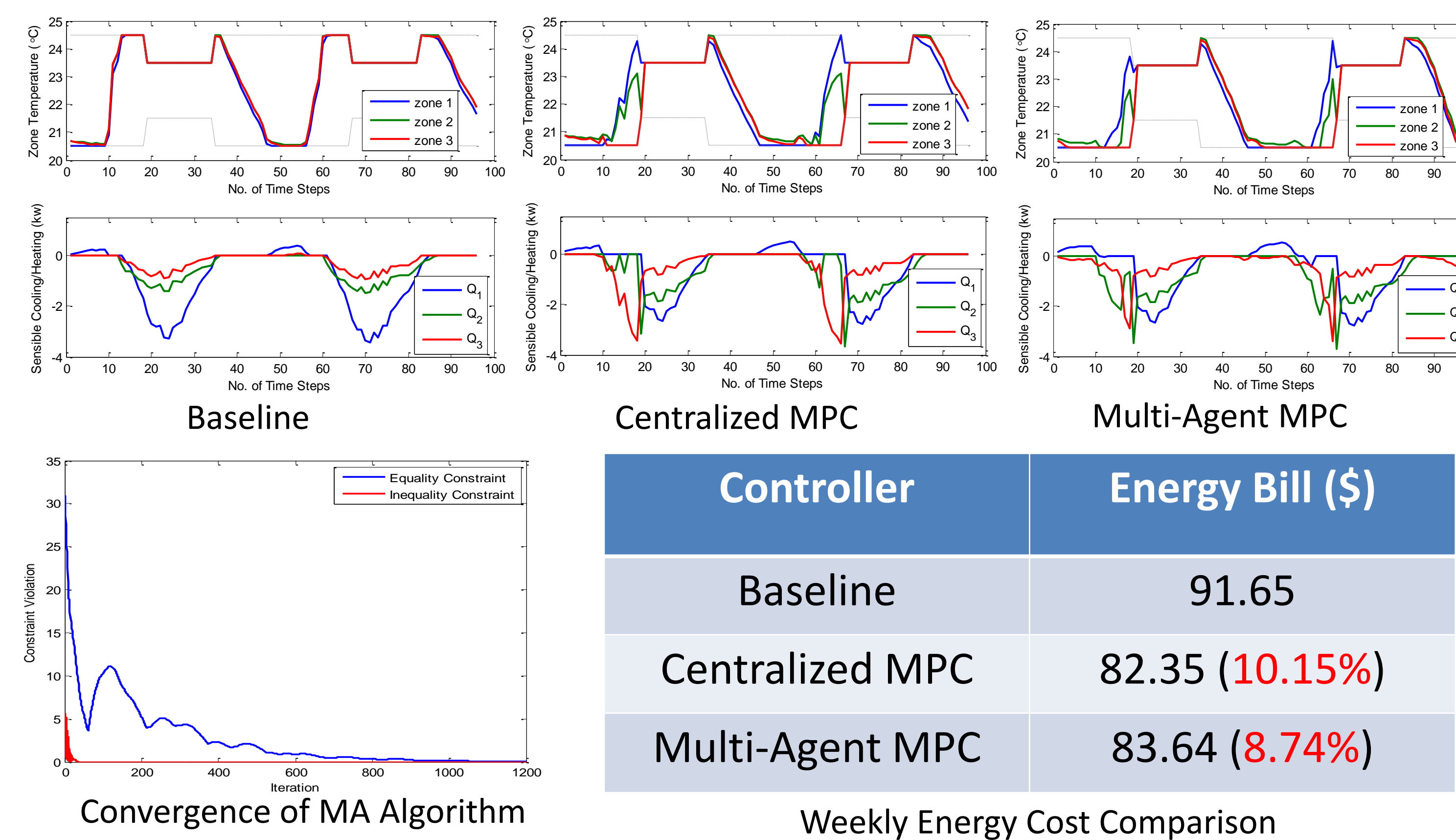


Multi-Agent Controller

- Each zone has an agent for its energy minimization
- Agents coordinate through information exchanges
- Gauss-Seidel ADMM
- Proximal Jacobian ADMM



Results:



Conclusion:

- Convergence of multi-agent (MA) algorithm relatively fast
- Precooling and inter-zone coordination observed in MA solutions
- MA control achieves most of the energy saving by the centralized MPC

Experimental Testbed

Purdue Living Lab 3 (LL3)



Purdue R. W. Herrick Laboratories



Living Lab 3 (LL3)

- VAV diffusers allow continuous and localized comfort control

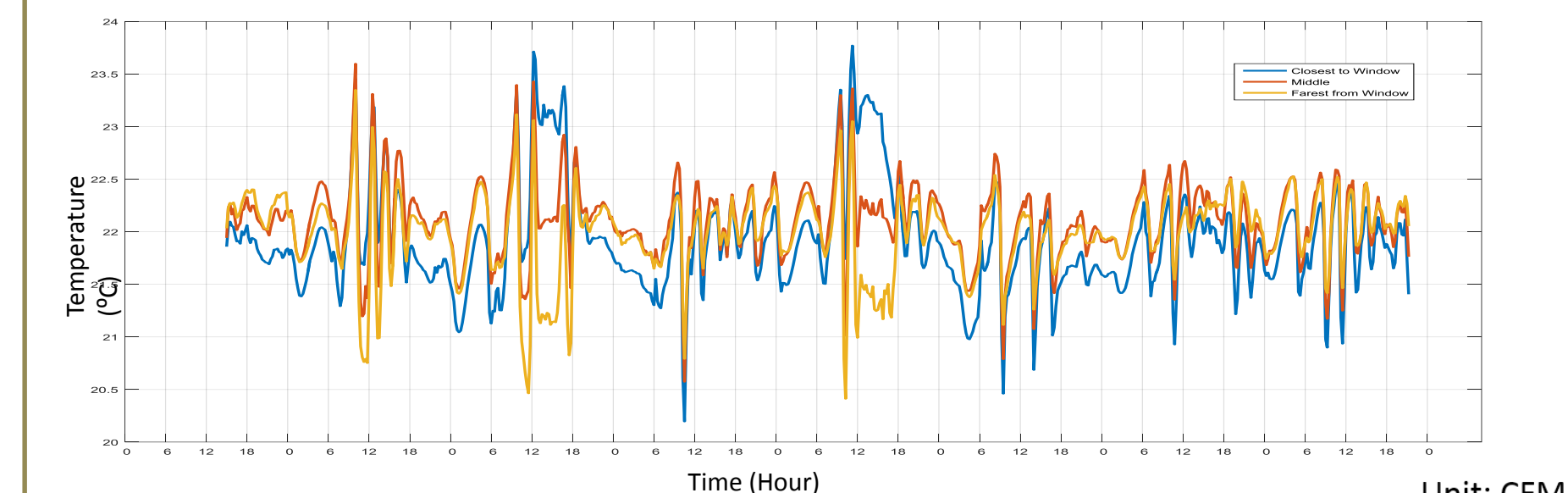
VAV diffuser with adjustable damper position

5% opening

50% opening



- VAV diffusers installation and testing

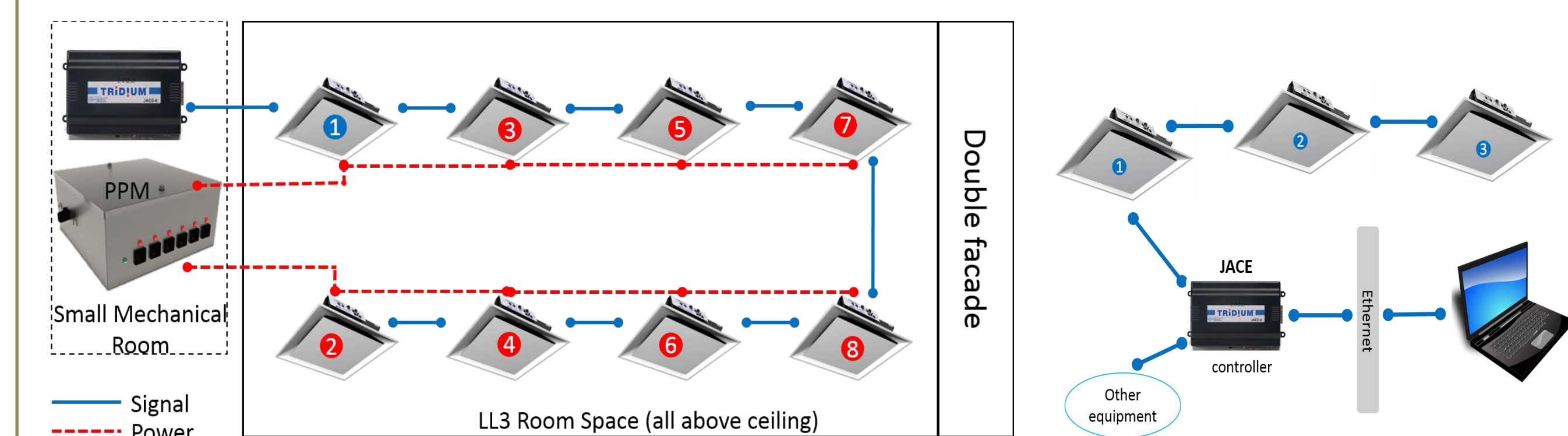


Opening	No.1 (VAV diffuser)	No.2 (Traditional)	No.8 (Traditional)	VAV Box (B+C)
0%	29	91	89	724
25%	54	91	84	724
50%	67	88	84	734
75%	79	87	81	734
100%	88	86	80	724

Unit: CFM



- Control Configuration (8 VAV diffusers)



- Thermo-coupled sensors configuration

