

The objective of this research is to develop methods for the operation and design of cyber physical systems in general, and energy efficient buildings in particular. The approach is to use an integrated framework: create models of complex systems from data; then design the associated sensing-communication-computation-control system; and finally create distributed estimation and control algorithms, along with execution platforms to implement these algorithms. A special emphasis is placed on adaptation. In particular, buildings and their environments change with time, as does the way in which buildings are used. The system must be designed to detect and respond to such changes.

Intellectual Merit: The proposed research brings together ideas from control theory, dynamical systems, stochastic processes, and embedded systems to address design and operation of complex cyber physical systems that were previously thought to be intractable. These approaches provide qualitative understanding of system behavior, algorithms for control, and their implementation in a networked execution platform. Insights gained by the application of model reduction and adaptation techniques will lead to significant developments in the underlying theory of modeling and control of complex systems.

Broader Impact: The research is expected to directly impact US industry through the development of integrated software-hardware solutions for smart buildings. Collaborations with United Technologies Research Center are planned to enhance this impact. The techniques developed are expected to apply to other complex cyber-physical systems with uncertain dynamics, such as the electric power grid. The project will enhance engineering education through the introduction of cross-disciplinary courses.