Ontological Controls In Smart Buildings
Parastoo Delgoshaei1, Mark Austin1, Amanda Pertzborn2

1 Department of Civil and Environmental Engineering, Institute for Systems Research, University of Maryland, College Park, MD.
2 National Institute of Standards and Technology (NIST), Gaithersburg, MD.

Motivation:

• Modern HVAC systems in buildings consist of thousands of devices from local dampers, heaters to boilers, air handling units, chillers and cooling towers.
• Over time, efficiency of HVAC systems tends to degrade from the optimum.
• Intelligent agents distributed throughout a HVAC system would orchestrate the operation of all components so as to maintain peak performance.

Long History with little real-world progress:

• Individuals spend 80% of their life indoors.
• Commercial buildings account for about 19 percent of the total and a third of electric power consumption.*
• Energy management in the buildings are least optimized (PI, PID Controllers with one or two levels of heuristics).**
• Energy-eating operations can be accomplished far more efficiently by more intelligently control strategies.

Goal: Develop a software infrastructure for distributed intelligent control strategies in smart buildings:

• Define semantics of domains in domain-specific ontologies (RDF, Jena API).
• Loosely couple each semantic model to a semantic interface.
• Capture domain constraints as governing rules and import them into ontologies.
• Provide message-passing mechanisms among all semantic model interfaces.

Towards Intelligent Building Agents

• Collect extensive data from sensors in the buildings.
• Identify the current status of all equipment/systems.
• Store data in semantic graphs of ontologies.
• Exploit message passing mechanisms for agent communications.
• Utilize inference engines to perform automated rule-based decision making techniques on data.
• Solve for of local (individual) vs. global (system-wide) optimums.

Current Framework for Ontological Controls in HVAC Systems in Smart Buildings

Current Features:

• Designed computational cores that can reason with physical quantities (not just numbers), time and space.
• Designed component hierarchies and networks, and component ports that work with physical quantities.
• Embedded physical quantities, ontologies, and reasoning capability deeply into scripting languages. Script and solve practical applications.