

E-SDMS: ENERGY SIMULATION DATA MANAGEMENT SYSTEM SOFTWARE ⁺

PI: K. Selçuk Candan; Co-PI: Maria Luisa Sapino

* School of Computing, Informatics, and Decision Systems Engineering, Arizona State University, Tempe, AZ 85287, USA

External Collaborator: Youngchoon Park; Johnson Control, Inc.

Building Energy Management

- The **building sector** was responsible for **nearly half of CO₂ emissions** in US.
- According to the US Energy Information Administration, **buildings consume more energy than any other sector**, with 48.7% of the overall energy consumption.
- Building energy consumption is projected to **grow faster than the consumptions of industry and transportation sectors**.
- By 2030 **only 18% of the US building stock is expected to be relying on the current energy management technologies**, with the rest either having been retrofitted or designed from the ground up using smart and cleaner energy technologies.
- EnergyPlus** software includes **time-step based simulation** for many energy-related building parameters, including
 - location and climate** information,
 - building construction** information, such as building geometry and surface constructions,
 - building use** information, including the lighting and other equipment and the number of people in each area
 - building thermostatic control** information, including the temperature control strategy for each area,
 - heating, ventilation, and air conditioning (**HVAC**) operation and scheduling information, and
 - central plant information** for specification and scheduling of boilers, chillers, and other equipment.

If effectively leveraged, these large **model, simulation, and sensor/actuation trace data sets** can be collectively used for

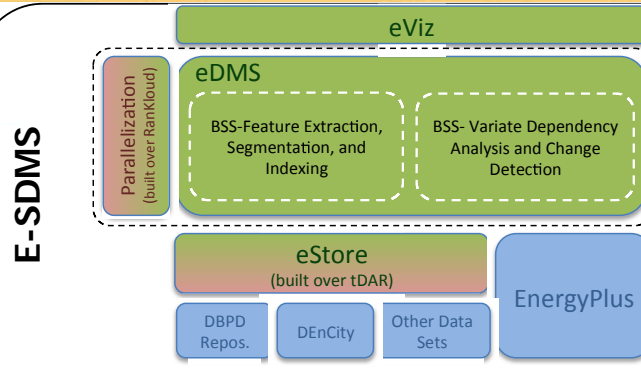
- revision of building models** (especially during retrofitting),
- supporting **search, analysis and exploratory, if-then type of analyses** of design alternatives.

Simulation Ensembles

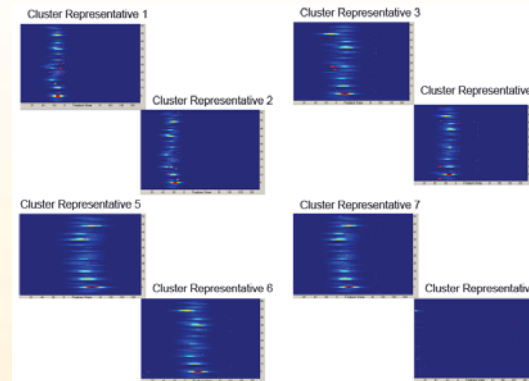
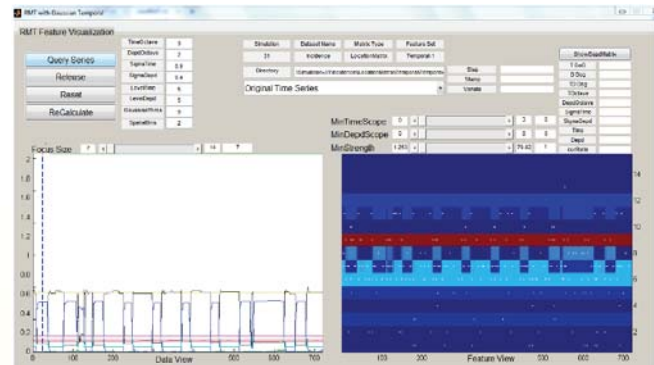
Generating an appropriate **ensemble of simulations** for decision making may require multiple simulations, each with different parameters settings.

Simulations track 10s or 100s of complex, inter-dependent parameters affected by complex dynamic processes. The **key characteristics** include the following:

- voluminous**,
- multi-variate**,
- temporal**,
- inter-related** (meaning that the parameters of interest are dependent on each other and constrained with the structure of the building), and
- multi-resolution** (meaning that simulations and observations cover days to months of data and may be considered at different granularities of space, time, and parameters).



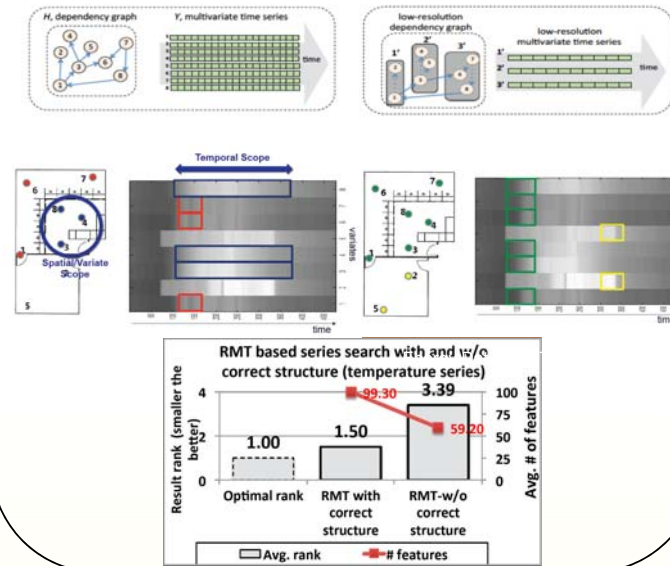
ES-DMS Interfaces



OpenSource Software Components

- OpenTSDB** – for scalable time series indexing
- Sedna XML Database** – for storing the building models and simulation parameters.

RMT Features



Project Timelines

Table 1. Project timeline

Task	Work Plan					
	Y1 H1	Y1 H2	Y2 H1	Y2 H2	Y3 H1	Y3 H2
Definition of the BSS data mode						
eStore						
RMT feature extraction from traces						
Segmentation of traces						
Multi-resolution indexing of traces						
Visual analysis of trace data sets						
Discovering variate relationships						
Scalable change detection						
Parallelization of core operations						
eDMS						
Visual analysis of large data sets						
eViz						
Software integration						
Core use scenario 1 evaluation						
Core use scenario 2 evaluation						
Educational Impact						
Proof of concept demonstrations						

Table 2. Software dissemination timeline

Task	Timeline			
	Y2 H1	Y2 H2	Y3 H1	Y3 H2
Release of eStore				
Release of eViz				
Release of non-parallel eDMS				
Release of parallelized eDMS				
Release of integrated e-SDMS				

Y: Year, H: Half year.