

## Project 3.8 Campus as a Laboratory

Mark Rice, Paul Ehrlich, Sen Huang and Robert Lutes

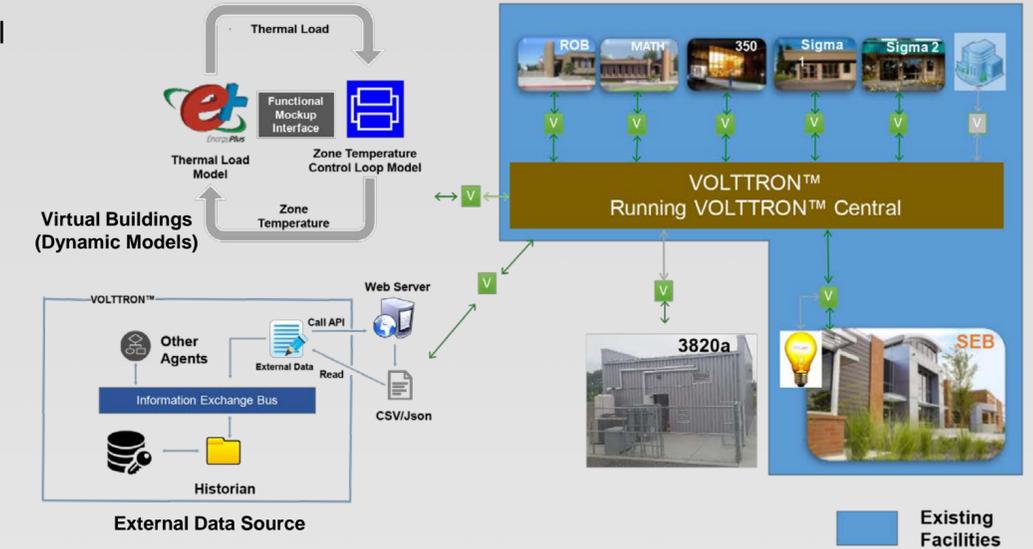
### Objective

This project aims to enable and enhance the use of test beds

- Supporting research teams from FA1, FA2 and other PNNL projects
- Establishing a process for test beds starting with simulation, connecting to hardware in a lab and finally to occupied buildings.

### Methodology

- Expand the test bed infrastructure to include additional new laboratories and buildings
- Document experiment workflow for use of the test bed facilities and its connected resources
- Develop a process to coordinate with facility operations and assure safety and reliability for use of occupied buildings
- Conduct a suite of experiments in which test bed facilitates work as intended
- Integrate with PNNL-developed tools including VOLTRON™, XMS and Pacifica

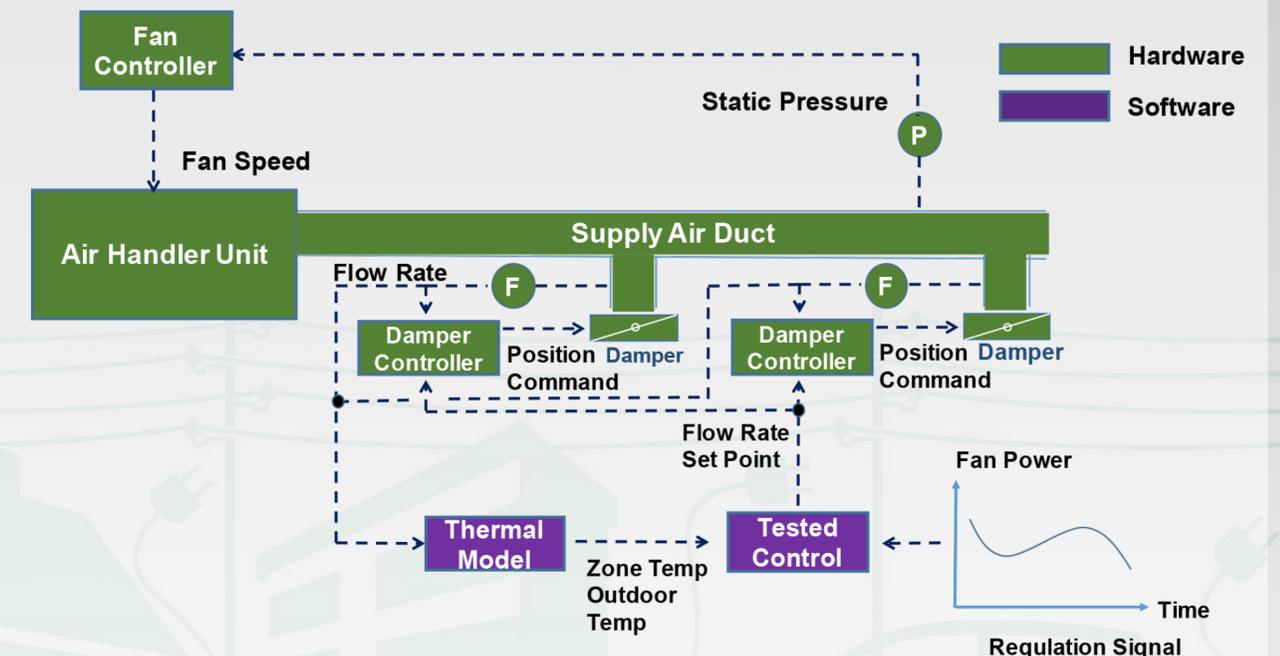


### Results

- 1. Developed the capability to incorporate building modeling tools**
  - Created VOLTRON™ Agents to communicate with Dymola/EnergyPlus
  - Used test bed to demonstrate hardware-in-the-loop simulation
- 2. Implemented the mechanism to stream external data sources to VOLTRON™**
  - Employed APIs from external web services to obtain the json/csv data
  - Created VOLTRON™ Agent to publish obtained data to VOLTRON™ platform
- 3. Expansion of test bed facilities**
  - Relocated and expanded air handler test lab
  - Improved use of the Systems Engineering Building through updates
- 4. New test bed process addresses:**
  - Access to controllers
  - Process for approvals, scheduling, managing tests, and returning systems to original conditions

#### Future work:

1. Expansion of laboratory test beds to include more systems
2. Control system updates to allow for improved integrated testing
3. Expansion to additional buildings on campus



**Hardware-in-the-loop simulation, which is designed to demonstrate how buildings can be controlled to provide services to the grid**