

Building Automation Systems in the Intelligent Smart Grid

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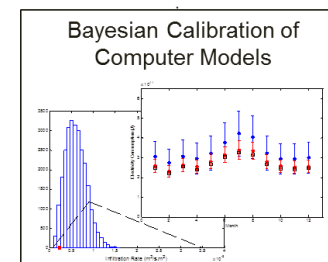
- Argonne's Building Energy Decision and Technology Research (BEDTR) program is focused on increasing energy efficiency of America's building through better energy efficient decisions

Better Decisions + Better Technology = Better Buildings

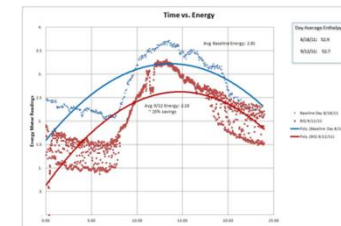
- Recent Projects Include
 - Stochastic building energy modeling
 - Bayesian Calibration of Energy Models
 - Proactive Energy Management using model predictive control with forecasting



Building Energy Decision
and Technology Research

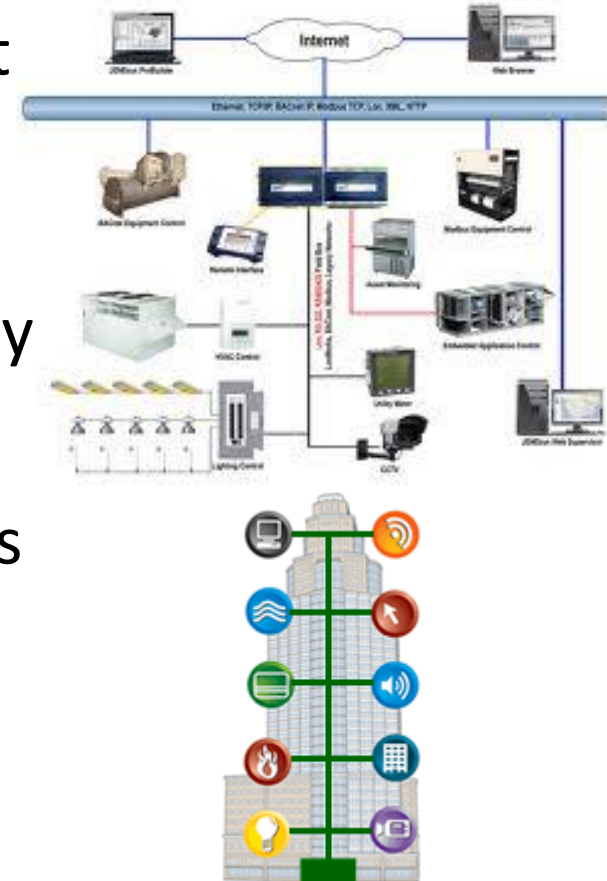


Proactive Energy Management



What Can A BAS Do?

- Collect, store, and transmit data about building loads, systems, and the grid
- Analyze data and develop control strategies to reduce energy use, energy costs, and improve occupant comfort
- Provide fault detection and diagnostics (FDD) for building systems
- Integrate HVAC, access, security, fire protection, IT, A/V, and other building systems in a single user interface



What Does A BAS Really Do?

- In most buildings now, the BAS merely collects data and provides a fixed set of building operation modes
 - No adaptation, No optimization, No FDD
- Most buildings have no BAS at all
 - Small to medium buildings (floor area < 5000 m²) make up the bulk of the building stock
 - Very few of these have any sort of BAS and what they have is usually extremely limited

DOE R&D Focus for BAS

- Get BAS into Small to Medium Buildings to enable savings in biggest untapped market
- Use BAS to Enable/Improve FDD to improve energy savings and reduce energy waste
- Use BAS to improve Building/Grid Integration
- Focus on open systems/protocols and interoperability
- Much BAS R&D use Funding Opportunity Announcements (FOA) where industry and academia can propose solutions directly to DOE

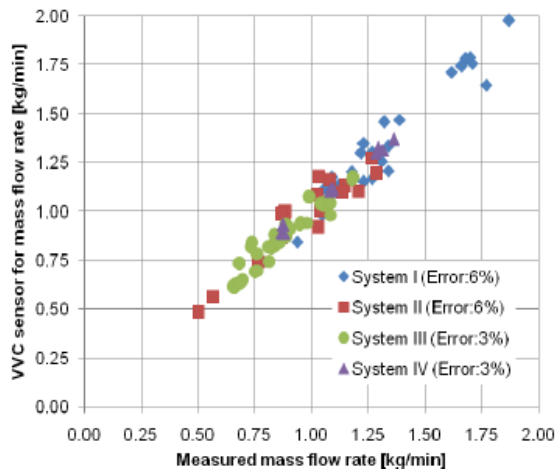
DOE Focus 1: BAS for Small/Med



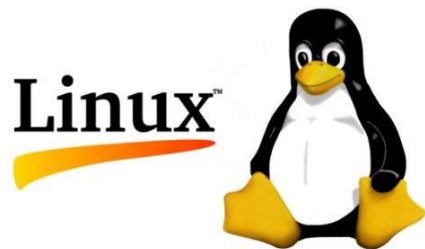
- Reduce the cost to install and maintain BAS
 - Secure wireless communications using non-proprietary protocols
 - Easy methods to locate and identify sensors
 - “Peel and Stick”
 - Low power for very long term battery life or or energy harvesting
 - Self calibration/self commissioning
- Retrofits for existing equipment the enable BAS connectivity



DOE Focus 3: BAS for FDD



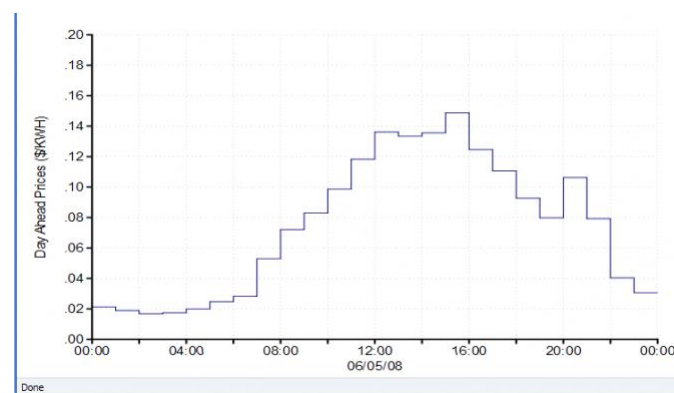
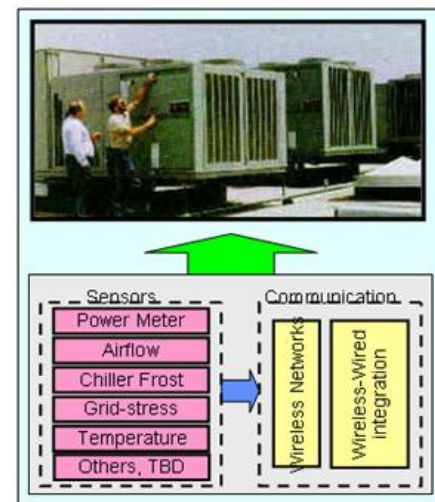
- Use networks of low cost sensors connected through BAS to create “virtual sensors” to replace expensive and difficult to install
 - Refrigerant flow in A/C systems
 - Air mixing in large rooms



- Open source algorithms running on BAS that understand system operation and look for deviations to detect and diagnose faults

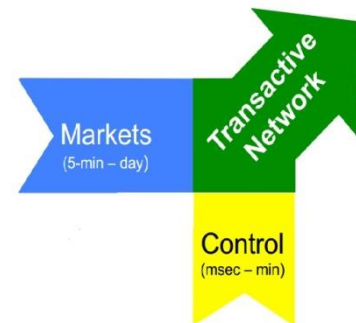
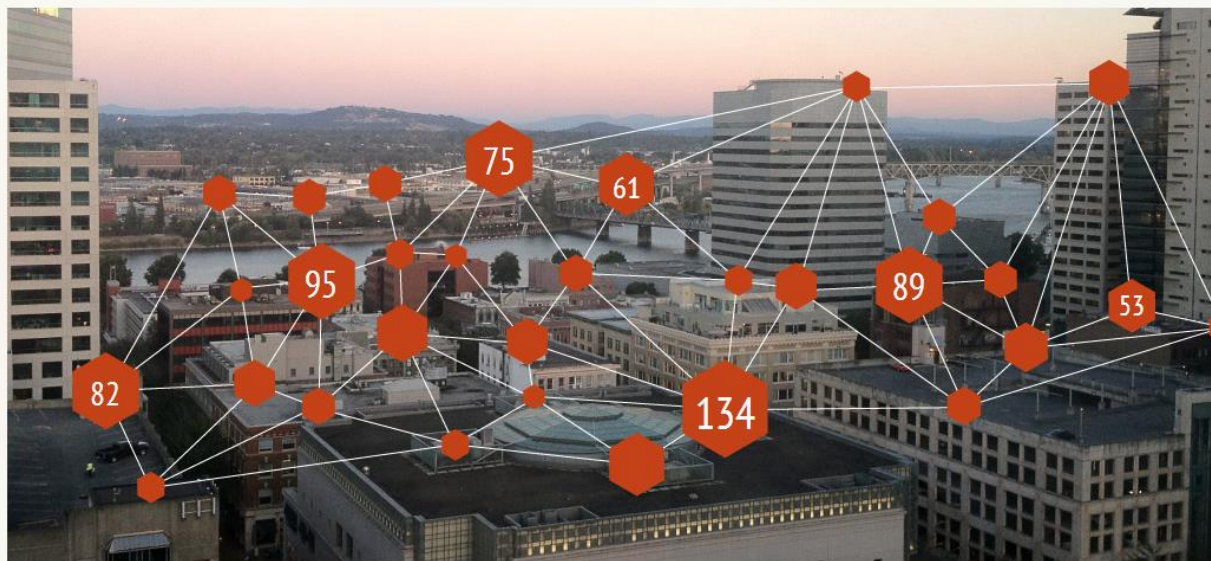
DOE Focus 2: BAS/Grid Integration

- Provide Platform to connect Equipment between buildings and to/from Grid using BAS
- BAS will learn and publish building capabilities and assets to the grid
- BAS will enable transaction based control
 - Real Time Energy Pricing
 - Demand Response
 - Energy Storage For the Grid



RTU Transactional Network

- DOE is supporting development of a grid connected network of Rooftop Units (RTU)s on several buildings communicating through BAS to talk with each other and respond to real time pricing and demand response requests as an integrated whole
 - <http://www.transactionalnetwork.org>



FDD/Virtual Sensors for RTU

- DOE is supporting development of virtual sensors for HVAC components to add new measurement capabilities to existing equipment
- DOE is supporting development of open source algorithms to monitor the performance of a RTU and detect common faults using existing RTU and controls sensors

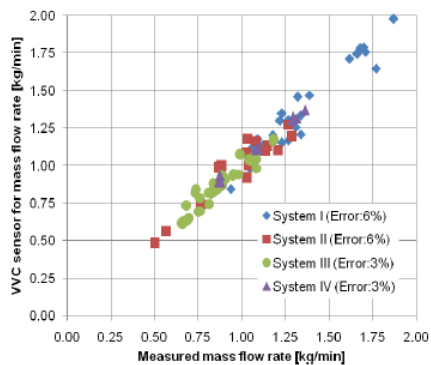


Figure 3: Performance of VRMF sensor (mass flow rate) under no fault conditions

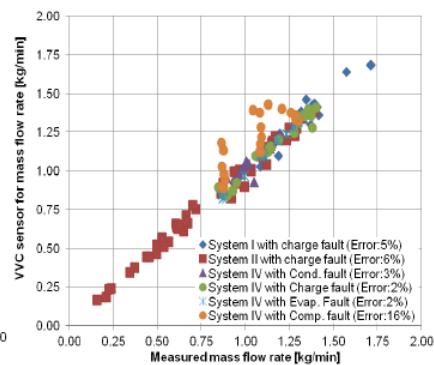


Figure 4: Performance of VRMF sensor (mass flow rate) under fault conditions

